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MAN-POWER IN GREAT BRITAIN

2. SCIENTIFIC RESEARCH, TECHNICAL TRAINING AND THE UNIVERSITIES

THE debate on Defence Policy in the House of Commons on March 4 and 5, while focused on the Statement Relating to Defence (Cmd. 6743. London: H.M.S.O. February 1945. 2*d*. net), was essentially a continuation of that during the previous week on economic affairs in relation to man-power. Both were equally concerned with the means of answering the Prime Minister's call for increased efficiency in production and for a higher output. But whereas the first debate was concerned essentially with the means for securing the maximum output and the most efficient use of industrial man-power in Britain once it is distributed, the second debate was concerned with the more fundamental question of the right distribution of available man-power between the Armed Forces themselves, the industries which supply these forces with equipment and weapons, the Government and other public services and the industries which supply the needs of the civil population and the export trades.

Nothing was said in this debate to suggest that efficient management is not of first importance; on the contrary, concern was expressed as to whether the Services, which have so much to teach industry about the selection of men and women, are making the most efficient and economical use of their own personnel. The importance of providing very much larger numbers of administrators, business managers, scientific workers, teachers, architects, medical men and others of the professional and managerial classes to meet the post-war needs of Great Britain in reconstruction and production was fully recognized, and more than one speaker was anxious as to the manner in which the re-distribution or re-allocation of scientific men is being conducted, with the closing down of certain branches of research effort inaugurated to meet war-time needs. The general recognition of the supreme importance of an adequate research policy and effort was one of the features of a debate of special interest to scientific workers.

The White Paper itself puts concentration on research first among the four principles guiding the Government in regard to the supply of equipment. Scientific and technical progress at the present time is so rapid that safety lies far more in the maintenance of an adequate organisation for pure and applied research than in the building up of stocks of obsolescent equipment. This declaration was generally welcomed in the debate, and, in pursuing the idea, Sir Ralph Glyn stressed the vital importance of association between young men and women in universities and technical schools, and contact between the best brains in the universities and the General Staff, the Admiralty and the War Office. Other speakers urged that everything possible should be done to keep us not only abreast but even ahead of other countries in research. Brigadier Head suggested that the

greater part of the money for scientific research should be held in a central pool and used to investigate the major scientific questions of the day. Allocations, and applications of the results to the respective Services, could be arranged later.

Brigadier Head was also among those who raised the question of continuity of service in defence matters of the leading men of science, and while, as Mr. Herbert Morrison said in the House of Commons on March 18, the need for scientific workers in the universities and the teaching profession and in industry is so pressing that the Government would not be justified in delaying the release from Government service of any one of them whose retention is not absolutely essential, some uneasiness is evident as to the manner in which their release and re-allocation are being effected. Two questions directed to the Lord President of the Council on March 18 both appear to have been prompted by the manner in which scientific and technical staff at the Royal Aircraft Establishment has been declared redundant, and it was suggested in these questions that there is a lack of overall co-ordinated planning of scientific research which will prejudice any action on the expected report of the Committee on Scientific Man-power.

What is possibly most encouraging in this debate to the man of science is the extent to which the implications of the policy advocated have been grasped. The first line of approach is that the major concentration must be upon the scientific research and technical training, and the use of the most modern technical equipment. The second line of approach is that the man-power must be the best that is available. The third is that we must achieve the utmost economy in the administration of the Services. Beyond this, of course, defence policy depends on foreign policy and the sum total of national resources; but what is satisfactory is to find explicit recognition that remuneration of the scientific worker must be adequate, that administration both in the Services and in industry requires continual overhaul if it is to be efficient and make appropriate use of modern methods of training and experience, and yet again that the new conditions demand a higher standard of education for those entering the Services, particularly for officers. A wide general technical and scientific education, knowledge of administration, and some kind of liaison with industry and opportunities for study in scientific and engineering concerns—these desiderata for the training of officers put forward by Lieut.-Colonel M. Lipton forecast growing responsibilities for the universities and technical colleges in this matter of defence.

This second debate in fact threw into even stronger relief the serious shortage of trained industrial leaders and professional men of all types for defence, for production and for the administration of the new services which the State is coming to render. To provide such educated men and women is pre-eminently the function of the universities, and if the demand cannot at present be met, it is to the universities that the community must look to replenish the supply. Yet the strongest criticism of the White Paper and of the Government's policy is that it is making it impossible for the universities to plan even for the coming academic year.

It is true, of course, that the Government has already announced that the grant to the universities for 1946–47 will be £9,450,000—an increase of £3,000,000 on last year, a sum which includes two and a quarter million pounds for capital grants, a re-vote of £1,200,000 not spent in 1945–46 and an additional £100,000 for dental education. It is true also that the Minister of Education has taken steps leading up to the appointment of regional academic boards and that a national college of technology is to be established to marry pure and applied science, as recommended by the Percy Committee on Higher Technological Education. But so long as the Government refuses to decide the period of call-up for national service, neither the universities nor the technical colleges can make adequate plans.

If the permanent level of the British Armed Forces is to be of the order of three quarters of a million, with an annual intake under national service of some two hundred thousand, a period of service of no more than a year to eighteen months should suffice, in accordance with opinion expressed in the debate. Such a period would enable the student to complete his national service before proceeding to the university or technical college. It may well be desirable to allow some latitude in the date of calling up, as both Mr. R. A. Butler and Sir Arthur Salter urged. Mr. Butler was on very debatable grounds, however, in suggesting that eighteen is an unsuitable age for calling up those proceeding to a university. The evidence is rather that delay of a year in proceeding to a university would be of general advantage and lead to the average student profiting more from his university course.

A notable feature of the references to the continuation of national service in this debate was the recognition of its educational opportunities. No man-power or defence policy which neglects those opportunities can be regarded as adequate; and any policy of university expansion must clearly start from this assumption of a period of national service, of defined length and to be taken within certain specified ages. If that period of training is conducted in accordance with ideas expressed so well in this debate, there can be little doubt that the normal student will enter the university or technical college very much better equipped and much less prone to the weaknesses of excessive specialization than in the past.

The prominence thus given to this question of university students as part of the problem of allocating the man-power resources of Great Britain directs fresh attention to the quantitative aspects of university expansion. That question has been briefly considered in various reports on the universities and scientific research, and was the subject of a special article by Sir Ernest Simon in the *Political Quarterly* in December 1944. It has been examined more recently from a fresh point of view in a series of three articles in the *Economist*. These articles start from the basic assumption that more university graduates are required for the country as a whole. Before a large increase in the size of the British university

system is decided upon, however, the preliminary question must be asked: Is there a sufficient supply of potential students capable of profiting from a university education? That question can really be resolved into two: first, is there enough innate capacity in the population; and secondly, whether a sufficient number of those innately qualified managed to stay the course to the age of eighteen. Sir Ernest Simon, touching briefly on the former question, pointed out that we do not know whether 1·5 per cent or 14 per cent of the population are worthy of a university education. A two-year research project now being undertaken at the University of Manchester under the direction of the professors of education, psychology and economics, has yielded results which suggest that, on a conservative estimate, 10 per cent of the population are of a level of intelligence to justify entry to a university.

While there is thus no question of a shortage at the original source, there is still an enormous leakage of the innately qualified at the age of fourteen, and another great efflux at sixteen. The Education Act of 1944, to provide secondary education for all, should partly remedy this position; but much will depend on the way in which the Act is implemented —how quickly the leaving age is raised to sixteen, and how generously local education authorities provide inducements to the boy or girl of talent to stay on until eighteen and become potential university material. Some years will be required before the new secondary school system yields its fruits, and in the meantime the universities have to deal with those released from the Forces and seeking to complete or even initiate their training.

A substantial increase in the university population is thus possible within a comparatively short period, and to these two factors—the urgent need for more trained minds and the existence of untapped capacity —the *Economist* adds a third and imperative reason: the need for more scientific workers. Both the Hankey Committee and the more recently appointed committee under Sir Alan Barlow have yet to report, but the *Economist* is on sure ground in suggesting that the war-time impetus will push the universities a long way along the road of expansion, whether they wish it or not. It is the more important therefore that, if the drive towards the expansion of their science departments is likely to be so powerful, the universities should look to the healthy development of their arts faculties. Even before the War, art students were outnumbered by science students (counting those of medicine, agriculture and architecture)—22,000 as against 27,000. In the interval, there has been the almost complete stoppage of seven years to repair on the arts side; and to maintain a sound balance in the intellectual achievement and outlook of Britain, any increase on the science side should be accompanied by an only slightly smaller increase on the arts side.

The *Economist* article contributes a much closer analysis of the order of magnitude of the increases than is to be found in Sir Ernest Simon's article, or the reports from the British Association Committee on Post-War University Education, and the Parliamentary and Scientific Committee, and looks at the problem in two stages—short-term and long-term. For the short-term programme of ten to fifteen years, after pointing out that without much expansion in the universities, the ratio of full-time students to that of live births twenty years earlier was improving rapidly, it suggests that the pace will be set by the demand for scientific workers. Subject to the findings of the Barlow Committee, doubling the flow of science graduates within the next few years should be a conservative and not too difficult programme. Science faculties have been kept almost at full strength during the War, and are much more fortunately placed than the art faculties to overcome the most acute bottleneck in any scheme of expansion, namely, that of staffing. Probably fifteen years will be required by the arts faculties to achieve the same proportional increase, and the two together would give as a short-term target a student population of 100,000 in 1960, or about 4·75 per cent of the children born in 1940 would reach the university.

This figure is considerably beyond Sir Ernest Simon's estimate, though of the same order as that contemplated by the Parliamentary and Scientific Committee and the Association of Scientific Workers; but for the long-term programme, which if well planned should be less hampered by the immediate problems of man-power and buildings, the *Economist* suggests as a *prima facie* target a further 50,000 in the following fifteen years. This would raise the ratio to more than eight per cent, or close to the estimated ten per cent of the population possessing the innate capacity. Moreover, it would involve a much more than proportionate increase in the number of women students—probably something like six-fold in thirty years—if the ratio for men is not to rise to twelve, a figure which is possibly higher than can be sustained.

In the second of the three articles, the *Economist* discusses in some detail the way in which these large increases could be effected in terms of the size and number of universities and the total cost of such an expansion. The approach adopted in these articles makes the discussion much more practical, and indicates what is involved in the application of principles that have too often been discussed in the abstract without serious attempt to see where they would lead in practice.

As to the size of a university, a unit of 5,000 students is accepted as near the limit, and a university of this size is indeed regarded as undesirably large unless there is a substantial residential element. On this showing, Oxford and Cambridge are both already large enough; but with the acute pressure on university space and in view of their special advantages, it is reasonable to expect them to make some contribution to the overall problem. The suggestion in the *Economist* is for an increase of about a thousand at each, and mainly by the endowment of two new colleges for women at each university. Of the provincial universities of Britain, it is suggested that five could expand up to 5,000 students within fifteen years and that a number of others could expand to 3,000–4,000 in the same period, those, such as Reading, without a large population within daily

travelling distance acquiring a distinctive character by ample provision of halls of residence. A target of 29,000 students is suggested as a reasonable aggregate for 1960 for Birmingham, Bristol, Durham, Leeds, Liverpool, Manchester, Reading and Sheffield, while the University of Wales with its four constituent colleges might expand to 7,000. The four Scottish universities, on the other hand, already attract a higher proportion of the population, and a like proportionate expansion is not to be expected; the figure for the Scottish universities is put at 15,000. It is next suggested that the existing university colleges at Exeter, Nottingham and Southampton form a valuable nucleus for expansion and, whether or not they are given university status, they might well expand to 6,000 students in the period.

The University of London provides a special problem, with a student population on paper of 13,000 in colleges separate academically and geographically. The bold suggestion is made that the single university might be divided into four or five universities, each with a maximum of 5,000 students, utilizing the existing geographical groupings. With a total of 20,000 students in London thus attained, and some 10,000 from new foundations in centres of population such as Stoke-on-Trent, Leicester, Norwich, Plymouth, Bolton, Blackburn or Preston, Bradford or Huddersfield, which might eventually acquire university status, the *Economist* arrives at a total of 100,000 for 1960. No attempt is made to analyse the distribution of the 150,000 students suggested for 1975. It is, however, indicated that attainment of the 1960 figures will bring at least some universities to the optimum size. Any long-term policy of university expansion should therefore provide for the foundation of a few residential universities.

It is only at this stage that the *Economist* begins to look at the cost of such a programme, the main burden of which must inevitably fall on national funds. On the basis of the £6¼ million which supported 50,000 students in 1937–38 and a permanent rise of at least 50 per cent in the level of prices, a total of £30 million in 1960 and £45 million in 1975 is suggested as probable, of which £24 million and £35 million might fall directly on the Exchequer. Grants for capital expenditure would be additional.

These are of course substantial sums, though even the larger is only about half of one per cent of the present national income and is minute compared with a contemplated expenditure on old age pensions in 1975 of £452 million. What is most impressive about the figures is indeed the smallness of the expenditure required to provide Great Britain with its full supply of trained minds for scientific research, for technology and industry and administration in the Government service or elsewhere and for the professions. Nevertheless, the sums are large enough, and the ancillary problems of planning expansion and keeping the balance in intellectual questions as well as material matters are far-reaching enough to call for some new administrative organisation, and the *Economist* reiterates a proposal which has frequently been voiced for strengthening the University Grants Committee and providing a new body representing the universities.

In the last of the series of articles the problems of planning, recruitment, specialization and the like are not discussed in the detail of other recent reports, but the right questions are asked and the main issues are stated. The series as a whole is in balance and shows clearly not merely what is really involved in a policy of university expansion, but also the challenge that it presents to fundamental thinking within the universities themselves. Further, it emphasizes the need for the Government to evolve a constructive policy as a matter of urgency and to overhaul all departmental regulations and practices which needlessly waste intellectual ability. The questions raised must be faced as a whole, with all that is involved from the point of view of the re-training and transfer of those released from the Armed Forces and other Government service, of maintaining an adequate Scientific Civil Service as an element in defence policy and public administration, encouraging scientific industrial research on an adequate scale and also fostering creative thought and intellectual life and culture. The comprehensive review of the situation is essential to determine the wise use of man-power and woman-power; and to avoid, above all, waste of trained minds and scientific and technical skill which are so urgently needed in every section of the national life to-day. Such a review underlines the need for an early report from the Committee on Scientific Man-power and for the widest publicity for its findings and recommendations.

ADVANCES IN BIOCHEMISTRY

Annual Review of Biochemistry

Edited by James Murray Luck and James H. C. Smith. Vol. 14. Pp. xi+856. (Stanford University P.O., Calif.: Annual Reviews, Inc.; London: H. K. Lewis and Co., Ltd., 1945.)

DURING the past few decades, progress in biochemistry has accelerated to such an extent that few active workers in the subject can afford the time to keep abreast of all the major advances by reading original papers. This particularly applies to the university teacher, who, if he is, as he should be, also a research worker, may find that his free time from the laboratory is nearly fully occupied in reading original papers relevant to his own field of research, leaving him little leisure in which to keep his lectures up to date. The recognition of this state of affairs by a group of Californian biochemists led to the publication in 1932 of the first volume of the "Annual Review of Biochemistry". The intention of the editors, as is clearly stated in the preface to this first volume, was to provide some relief from "the task of constantly referring to original works" by providing, annually, critical and up-to-date surveys of the literature in some twenty to thirty major fields of interest in biochemistry.

The "Annual Review of Biochemistry" for 1945 is the largest volume that has so far appeared in the series, running to 856 pages inclusive of the indexes. The twenty-eight articles which it contains are on the average well up to the standard that has been set in the past; and the new volume, like its thirteen predecessors,

will doubtless find a place on the bookshelves of most English-speaking biochemists. I am, however, doubtful whether the average standard of the articles in the "Annual Review" has ever been so high as would be desirable, and it appears to me that this publication has never satisfactorily fulfilled the original purpose intended for it by the editors.

In every volume of the "Annual Review" a not inconsiderable number of the articles have been uncritical compilations of references rather than critical surveys, and it is difficult to avoid the suspicion that in some cases they may owe more to efficient secretarial help and well-arranged card-index systems than to the specialized knowledge and critical abilities of the reviewers. Such uncritical catalogues of references are, of course, very useful to have beside one, but as all who have attempted to prepare lectures with the aid of the "Annual Review" will probably agree, they afford one little relief from "the task of constantly referring to original works". It is little exaggeration to state that some of the articles that have appeared in the "Annual Review" are scarcely more useful to the biochemist who is trying to keep his general knowledge of the subject up to date than a good abstract journal would be.

It seems likely that if the "Annual Review of Biochemistry" is to maintain its popularity in the face of the competition provided by some of the more recent review publications of American origin, a somewhat stricter attitude of the editorial board towards those who are invited to contribute articles may be necessary in the future. If all contributors could be persuaded to limit their articles to a few topics which were ripe for review, and which they were fully competent to discuss critically, the usefulness of the "Annual Review" to the average biochemist would be very greatly increased.

The present volume contains some outstandingly excellent articles which I have read with considerable pleasure and profit. Among these are the following: "Biological Oxidations and Reductions", by H. A. Lardy and C. A. Elvehjem; "X-ray Studies of Compounds of Biochemical Interest", by I. Fankuchen; "The Chemistry of Antibiotic Substances other than Penicillin", by A. E. Oxford, and "The Biochemistry of Malignant Tissues", by J. P. Greenstein. The last-mentioned article appeared to me to be almost a model of what a critical review should be. The same might have been said of the article by J. M. Gulland, G. R. Barker, and D. O. Jordan on "The Chemistry of the Nucleic Acids and Nucleoproteins", if it were not for the fact that almost all the references to original papers in the text are given in the form of bibliography numbers only. The omission of the names of authors of original papers from the text doubtless saves much valuable space, but in my opinion it greatly detracts from the readability of an article. It is difficult to concentrate on the subject-matter if one has to turn to the bibliography several times in the course of reading a single paragraph in order to ascertain the names of the authors to whose work reference is made. This practice of omitting authors' names from the texts of review articles is becoming a very general one and is greatly to be deplored.

I wish to take this opportunity to direct attention to errors in two articles which deal with topics about which I have special knowledge. On page 587, I am wrongly credited with the discovery of Δ^5-androstene-3 (β), 16, 17-triol in the urine of a boy with an adrenal adenocarcinoma. In the paper referred to it is made clear that this substance was isolated by Marrian and Butler from the urines of normal men and women, and that afterwards it was identified with the substance isolated by Hirschmann from the urine of a boy with an adrenal adenocarcinoma. In another article, on page 625, there seems to be an implication that Allen and Viergiver were originally responsible for devising a quantitative method for the determination of pregnanediol glucuronide in urine. As all workers in this field will know, the Allen–Viergiver method is a modification of the method originally devised by Venning, who in collaboration with Browne first isolated pregnanediol glucuronide as its sodium salt. G. F. MARRIAN.

COMPARATIVE STUDY OF ORGANISATION

The Individual in Simpler Form

By Arthur Russell Moore. (University of Oregon Monograph Study in Psychology, No. 2.) Pp. x+143. (Eugene, Oregon: University of Oregon Press, 1945.)

THERE can be few experimental biologists who have worked on such diverse orders of animals as Prof. A. R. Moore. His interests have ranged from the formless masses of nucleated protoplasm known as *Plasmodium* to the elaborate architecture of the central nervous system of vertebrates. If there is a 'ladder of being', Prof. Moore might be said to have a foot on each rung. His recent book is called a "Monograph Study in Psychology"; but his purpose is much wider than one might expect from this title. It is, he states in the introduction, to consider "the nature of individuality in embryogenesis and in animal behaviour" and to discuss "the meaning of ordered arrangement in giving coherence to the individual . . . in terms of increasing complexity". This is a very large order, and such an endeavour might easily evaporate into verbose discussion or mere compilation from the literature. It is thanks to Prof. Moore's extremely wide experience that he is able to deal with a numerous series of forms of organisation, of ever-increasing complexity, and still select the main topics of discussion from fields which he has himself studied and in which he can make original contributions to the material.

We start with the protoplasmic organisation of *Plasmodium*, a form in some ways simpler than *Amœba*, the conventional starting point of such discussions. It is perhaps a pity that Prof. Moore makes no mention of the behaviour of the nuclei. Our knowledge of nuclear control in lower organisms such as bacteria, moulds and fungi has recently advanced very rapidly, largely through the efforts of American biologists, and a comparison between *Plasmodium* and the heterokaryotic forms of these groups would certainly be interesting. But Prof. Moore has been affected by the profound cleavage which divided American experimental biology in the early years of this century into what might be called the Loeb and Morgan schools. He is a Loebian; and he looks at the world of living things through the well-known physico-chemical-behaviouristic spectacles. These make possible a penetrating insight into certain aspects of animal organisation, but tend to restrict the field of view.

Thus, when Prof. Moore passes on to his next degree of complexity, the egg cytoplasm, he is able to quote physico-chemical work of great interest, such as his

investigation of the reality of protoplasmic connexions between the blastomeres, of the internal osmotic pressure required to inhibit gastrulation, and of the influence of nucleus and cytoplasm in determining the rate of cleavage. But, in respect to the last of these particularly, his interest in the colloid chemistry of the cytoplasm, having first led him to the important conclusion that the rate of early cleavages is dependent on cytoplasmic factors, then tempts him to overlook the fact that the nucleus is the ultimate controlling factor. Indeed, the opposite view is suggested, though never quite explicitly stated, except in the sentence (p. 30): "These facts are in harmony with the view that the nucleus can be affected by environmental change only through the gateway of the cytoplasm, and they suggest the possibility that the first step in evolutionary transformation is a cytoplasmic change in response to the impinging forces of the environment".

After his two long chapters on the blastula and gastrula, Prof. Moore moves on to another field, that of the physiological analysis of behaviour. As an example of an aganglionic central nervous system in action, he discusses the movements of starfish, and the extensive series of experiments which he and his associates have made on them. Then we go on to the function of the head ganglion in polyclads, and of the ganglion chain in earthworms and other forms. Finally, there is a discussion of "Some Intrinsic Factors in Nerve Function" (mainly drug stimulation in cephalopods) and "Habit Formation as a Basis for Mind" (training experiments on the snap reflex in axolotl larvæ).

It is, as will be seen, a mixed bag that we are offered; but why should we be the less grateful for that? We have here a general exposition of the results achieved by an experimenter of inexhaustible energy, insatiable curiosity and a complete absence of the diffidence which prevents some men from straying outside a narrow field of 'expertise'. Prof. Moore must have enjoyed himself; and, although, as might be expected, some of his conclusions will be questioned, this record of endeavour and achievement is one which many biologists will envy him.

C. H. Waddington.

TAXONOMY OF *ASPERGILLUS*

A Manual of the Aspergilli

By Charles Thom and Kenneth B. Raper. Pp. ix+373. (London: Baillière, Tindall and Cox, 1945.) 38*s*. 6*d*.

THE publication, in 1926, of the monograph "The Aspergilli" by Thom and Church was a landmark in the taxonomic study of this important genus of moulds. The fact that a re-working of the genus after twenty years has necessitated no fundamental change in classification is the best evidence of the sound scholarship which went to the writing of the monograph. Nevertheless, its very excellence gave other workers confidence, not only in identifying Aspergilli, but also in describing new species, with the result that a fair amount of new material has accumulated during the intervening years.

As Messrs. Thom and Raper point out, the new book is not a monograph but a manual for the use of the laboratory worker, designed to enable him to identify any known species of *Aspergillus* which he encounters, and to trace, with the minimum of difficulty, the literature relating to its activities. The volume is divided into three sections, "General Discussion", "The Manual Proper", and "Reference Material". In the first part, history and systematic position of the genus are dealt with in two short chapters, the main emphasis being on practical considerations. General morphology and the criteria used in determination of species are discussed in considerable detail. Then come methods of cultivation, examination, and preservation of cultures, including a description, with illustrations, of the freeze-drying or lyophile process, a method by which the preservation of both morphological and biochemical characteristics can be ensured for considerable periods. Finally, there is a chapter on variation; and by this term is understood not merely the types of change which take place, sometimes by design but only too often otherwise, in cultures preserved in the laboratory, but also the natural variation in certain characters within a given species concept, often appreciated only when very large numbers of strains are examined in parallel cultures.

The second, and largest, part of the book, "The Manual Proper", is mainly taxonomic. The number of species described is rather surprisingly large, there being seventy-seven accepted species plus eight varieties and four mutants. However, a fair number of the species are known only from single isolations and, at present, cannot be considered as members of the normal mould flora. Also, the taxonomy is simplified by arranging all the species in groups around fourteen types; for, if we except the *A. glaucus* group, it is undoubtedly true that the great majority of isolates of Aspergilli belong to the typical species of these groups, and, as such, are readily identified. Quite logically, the general keys, of which there are three, including one in the form of a chart, lead to the groups rather than to individual species. As in the 1926 monograph, there is a separate chapter for each group, with a key to species where necessary; but the general lay-out of the material is much better than in the earlier work and at the end of each chapter is an account of the distribution of the species in Nature and of their economic importance.

The book is profusely illustrated. There are some line drawings to illustrate structure and a few plates from drawings, at very high magnification, of ascospores of various species in the *A. glaucus*, *A. fumigatus*, and *A. nidulans* groups. Most of the figures, however, are from photographs of colonies, portions of colonies, and typical fruiting heads. The majority of these are excellent and appreciably enhance the usefulness of the manual. In addition, seven plates reproduced from colour photographs show colonies, in Petri dishes, of all the important species. At first sight these are an attractive feature of the book, but they do not bear critical scrutiny. They are frankly disappointing and may, in fact, be misleading to the student, for in few cases are the tones even approximately correct.

On one point the authors have certainly laid themselves open to criticism. There is much to be said, from the practical point of view, for including in *Aspergillus* all species with the typical conidial fructification, whether or not they have a perithecial stage in addition; but few systematists will agree with the summary rejection of *Eurotium*, in complete disregard of the Rules of Nomenclature.

Apart from these minor blemishes, the book is excellent and a very worthy successor to the monograph which first put the taxonomy of the genus on a sound basis.

George Smith.

GENETICAL FACTORS CONCERNED IN THE SYMBIOSIS OF CLOVER AND NODULE BACTERIA

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IN spite of their intrinsic biological and evolutionary interest the genetical factors involved in symbiotic relationships have received very little attention. In the allied field of parasitism, the need for restricting variability of the host in the interests of experimental work has concentrated rather more attention on the genetical aspects of the host-parasite relationship. This has been achieved by the breeding of disease-susceptible and resistant lines of plants or animals for use as hosts in the study of variability in the parasite; but it is evident that correlated studies of variation in both host and parasite are required for a better understanding of the interrelations concerned in parasitism. In the case of insect-transmitted virus disease, Storey[1] has shown that the interrelations are even more complex because the genetic constitution of the vector may also have to be taken into account.

In the study of symbiosis a similar mode of approach is desirable, and although no specific studies on the inheritance in leguminous plants of factors relating to symbiosis appear to have been made, a number of authors have suggested that hereditary factors in the plant may account for some of the differences in behaviour observed between species and between varieties of the host plant. Wilson[2], while studying cross-inoculation, found that occasionally sporadic and unpredicted nodule formation was promoted on certain plants or group of plants by bacteria known to form nodules on plants of other cross-inoculation groups, and claimed that this was related to the capacity for cross-fertilization shown by the plants in question. Self-sterile leguminous species appeared to have the widest range of infectability by *Rhizobium* species and self-fertile ones the narrowest, and he suggested that in the former the greater genetic diversity encouraged more frequent promiscuous nodule formation.

Wilson, Burton and Bond[3], Bjälfve[4] and others have also described variations in the amount of fixed nitrogen utilized by different varieties of plant when associated with the same strain of bacteria; these differences were thought to be attributable to hereditary traits in the plants.

During the last three years, studies on the inheritance of some of the factors concerned in the symbiosis between red clover and nodule bacteria have been in progress at Rothamsted. Such genetical researches are necessarily protracted because of the time taken by the clover plant to flower, the single seed produced by each pollinating operation and the self-incompatibility of red clover, but an account of the preliminary results obtained may be of general biological interest.

Original selections were made from commercial and Aberystwyth strains of red clover, the individual plants of which were grown under standardized conditions in test-tubes on agar slopes containing mineral nutrients but lacking combined nitrogen, and inoculated with a pure line strain of bacteria. From these cultures plants were selected according to (1) the presence or absence of nodules, (2) the stage of seedling growth at which primary nodule formation took place, (3) the number of nodules formed, and (4) the so-called 'effectivity' of the plant response, by which is generally implied the degree to which the plants are able to obtain their nitrogen supply from the nodules when grown on a medium totally deficient in nitrogen. The terms 'effective' and 'ineffective' are usually employed with reference to differences between bacterial strains, an ineffective strain being one which promotes nodules which are without visible benefit to the plant. The effective and ineffective strains employed in the experiments to be described are named strain A and strain H.K.C. respectively. The selected plants were transplanted to soil, pollinated by hand, and the behaviour of their progeny with the same bacteria later studied under similar controlled conditions.

Variation in all the criteria mentioned above have been found to be associated both with variation in the bacterial strain and with differences in the plant of a genetic nature.

With regard to the first category, that is, the presence or absence of nodule formation, one plant only has been discovered among the many thousands of plants raised from commercial seed which was 'resistant' to normally infective bacteria. This unique 'resistant' plant was casually pollinated and from the progeny a 'resistant' line has been raised. A very condensed summary of the results obtained in further crosses is given in Table 1, and the breeding behaviour suggests that 'resistance' was inherited as a recessive in conjunction with a possibly cytoplasmic maternally transmitted component.

It is known that bacterial strains differ specifically in the mean number of nodules per plant which they produce[5], but variation in the numbers produced by any given strain appears also to be determined by genetic factors in the plant. The progeny of crosses between plants forming few nodules themselves have few nodules, and plants with many nodules crossed *inter se* give progeny with many nodules; but in crosses between the many and few nodule types the progeny form an intermediate number of nodules.

TABLE 1.
INHERITANCE OF 'RESISTANCE'.

	Type of cross ♀ Parent	×	♂ Parent	Number of parent plants	Segregation: With nodules	Segregation: Without nodules	% Set of seed
P	Original 'resistant' plant	×	Susceptible casual plants	Number of male parent plants unknown	132	17	—
F_1 (i)	*r**	×	*r*	2	0	27	2·4
	Reciprocals			2	0	11	
(ii)	*R**	×	*R*	6	137	48	48·0
	Reciprocals			6	188	63	
(iii)	*r*	×	*R*	6	34	29	47·0
	Reciprocals			6	33	52	
Outcrosses	*r*, (F_1)	×	*R* (from stock)	7	92	17	41·0
	Reciprocals			7	137	0	52·0
	r (F_1)	×	*R* (from stock)	17 ('*R*' parents different)	253	0	39·0
	Reciprocals			17	363	0	
	R (F_1)	×	*R* (from stock)	18	343	0	53·0
	Reciprocals			18	291	0	

* *r*, 'resistant' parent plant; *R*, 'susceptible' parent plant.

TABLE 2.
SELECTION FOR NODULE NUMBER.

Sum of parent nodule numbers with strain A	Mean progeny nodule number	
	With effective strain A	With ineffective strain H.K.C.
16 (6 + 10)	16·0 ± 2·3	—
26 (6 + 20)	16·6 ± 1·9	52·4 ± 6·1
69 (7 + 62)	24·1 ± 1·3	—
75 (7 + 68)	20·5 ± 4·2	—
184 (6 + 178)	25·3 ± 5·0	96·0 ± 13·8
240 (62 + 178)	40·2 ± 4·6	130·4 ± 10·8
253 (75 + 178)	30·7 ± 3·8	—

This is shown in the results of a typical selection experiment in Table 2; it is possible that a number of genes are concerned. As a rule inbreeding resulted in an increase in nodule number. The results in the table also show that genetic plant differences are not confined to symbiosis with any particular strain but influence the number of nodules formed to the same relative degree irrespective of the bacterial strain used. Thus an ineffective strain of bacteria (strain H.K.C.), which in comparison with an effective strain (strain A) commonly produces about three times as many nodules on unselected plant material, may nevertheless produce with one selected line of plants as few nodules as the effective strain will on a second selected line, though the effectivity response may remain unaffected by such plant differences.

An examination of plant variability with respect to the stage of development at which primary infection occurs has also revealed hereditary differences. Under the conditions of growth described, the first nodule formed on a seedling may appear at the unfolding of the first true leaf or may be delayed to a later stage in development, sometimes until the fifth or sixth leaf unfolds. The number and behaviour of the hereditary factors responsible have not yet been determined. The differences displayed by selected lines of plants greatly exceed the rather small differences in this respect which are known to be attributable to bacterial strain variation (within a single cross-inoculation group of strains). Here inbreeding led to delay in nodule formation, though, as in the number of nodules formed, the heterozygote was intermediate.

Finally, genetic factors in the plant have been found to influence the effectivity response. The study of these hereditary factors has been carried out using in general strain A and its derivatives as inoculants. The effectivity of this strain under ordinary conditions had been previously shown to be very stable by frequent testing of large numbers of single colony isolations in paired plant cultures (on the genetical side of the work inoculations were always made from single colony isolations). To avoid confusion in terminology these different symbiotic reactions in the plant, genetically determined, will be described as 'responsive' and 'unresponsive' to distinguish them from similar appearances obtained respectively with effective and ineffective strains of bacteria.

In association with strain A, unselected material showed about 2 per cent of plants ineffectively responding from which, however, only the effective strain of bacteria could be recovered in isolations from nodules. Crosses were made between seven such plants showing such anomalous symbioses, and in the majority the progeny were effective in their response. In one family, however, about one quarter responded ineffectively while in another family almost completely uniform ineffective plant response was obtained, so that genetic differences were undoubtedly concerned. This result suggested that a number of factors were involved; the effective response being dominant over the ineffective response.

Further investigation has shown that the uniform 'unresponsive' reaction in the last family mentioned (which will be called α) was due to a single homozygous recessive gene; and that when plants of this family were outcrossed to 'responsive' plants a fully 'responsive' progeny was obtained, the heterozygote being indistinguishable from the dominant homozygote. This 'unresponsive' reaction in the homozygous recessive was associated with the production of large numbers of small nodules and thus could not be distinguished from a typical ineffective symbiosis due to infection by an ineffective strain of bacteria.

The α family, however, gave a uniformly effective symbiosis with a number of other effective strains of bacteria unrelated to strain A, so that the 'unresponsive' reaction between α plants and strain A was due to an interaction between the homozygous recessive and a factor, or factors, specific to strain A. Furthermore, in later experiments a variant substrain of bacterial strain A appeared in a single large nodule on an α plant which, when isolated, was found to give an effective response with α plants; whereas parallel isolations from small nodules on the same plant gave the usual ineffective response. Several tests of re-isolates from each kind of symbiosis confirmed the appearance of a variant bacterial strain (mutant No. 1) able to form an effective symbiosis with α plants. The dry weight results from the second of these tests is summarized in Table 3.

TABLE 3.

	Mean dry weight per plant in mgm. (6 replicates)	
	Miscellaneous seed	α family
Strain A	69·4 ± 7·6	20·2 ± 4·2
Re-isolated strain A	65·2 ± 3·8	16·1 ± 1·9
Mutant No. 1	53·6 ± 4·7	58·8 ± 4·1
Re-isolated mutant No. 1	65·6 ± 4·4	56·4 ± 7·9

Finally, the symbioses of two further mutants of the bacterial strain A with selected lines of plant material may be considered as they further elucidate the nature of these differences both in the bacteria and in the plant. One of these bacterial mutants was obtained after prolonged culture at a low temperature and was of intermediate effectivity (mutant No. 2), and another which was totally ineffective on unselected plant material was obtained after desiccation in sterile soil culture (mutant No. 3). These mutants and the parent strain A have been shown to be culturally and serologically identical[6] and full details of their origin and behaviour will be published elsewhere. It should be noted that the mutant No. 2 was intermediate only in average plant response, a graded series of effective, intermediate and ineffective symbioses appearing on different plants; re-isolated substrains from nodules of any kind again giving similar variations of effectivity.

The results obtained in an experiment in which these different kinds of plant and bacteria were simultaneously tested are shown in Table 4, in which ordinary commercial seed of red clover was compared with two lines of plant material; the first a line derived from family α and homozygous recessive for

TABLE 4.

E = Effective symbiosis *EI* = Intermediate symbiosis
I = Ineffective symbiosis

Bacterial substrain	Montgomeryshire red clover	F_1 line, α	F_1 line, β
Strain A	*E E E E*	*I I I I*	*E E EI EI*
Mutant No. 1	*E E E E*	*E E E EI*	*E E E EI*
Mutant No. 2	*E EI EI I*	*I I I I*	*I I I I*
Mutant No. 3	*I I I I*	*I I I I*	*I I I I*

its 'unresponsive' reaction to the parent strain A, and the second, line β, deriving from plants that were 'responsive' to this strain. Both lines were equally inbred, the second acting in some measure as control against the effect of inbreeding in the α line.

The original strain A failed to be effective only with the α line although the response with the inbred β line was not fully effective. The first mutant was effective throughout though rather less so with both inbred lines. The intermediate mutant No. 2 only gave a partially effective response with the miscellaneous Montgomeryshire red clover material, and appeared to be quite ineffective with both inbred lines. The last mutant No. 3 was ineffective throughout.

This lack of an effective response in both inbred lines with the intermediate mutant and their diminished response with strain A and mutant No. 1 are additional interesting results. They suggest that (1) the intermediate strain of bacteria only gives rise to effective symbioses when associated with a number of dominant genetic factors in the plant, and (2) a number of recessives in the homozygous form reduce the response of the plant.

The general conclusion to be drawn from these results is that the number and activity of nodules formed on the plant depend upon the interaction of factors, in the bacteria and in the plant, both liable to change by mutation. It is also evident that critical studies in symbiosis demand the use of clonal lines of bacteria, as well as much fuller knowledge than is at present available of the inheritance and activity of the co-ordinating factors in the plant.

The relationship between the two organisms in symbiosis would seem to be much more complex than is generally supposed.[1] The investigation of other sources of variation, for example, size, shape and colour of nodule, cross-inoculation group specificity and no doubt also potency in nitrogen fixation would probably reveal other genetical patterns. The four sources of variation so far investigated have all proved to be independent of each other, and moreover are not in any way directly correlated with other plant characteristics of stem, leaf or flower. Nodule number has, however, been shown to be correlated with rooting habit, but this need not concern us here.

In comparing the inheritance in clover of the nodule characters described, two interesting contrasts appear. On one hand, in crosses between plants differing either in nodule number or in the time of their first appearance, the progeny are intermediate in character and in F_2 the increasing variability suggests that a number of factors are concerned. In both also no specificity is shown towards different strains of bacteria. These characteristics can vary within wide limits without apparently affecting the benefit derived by the plant from nitrogen fixation; and so changes in them, unless very large, will be non-adaptive.

On the other hand, the factors producing complete resistance to infection and those that alter the effectivity response are clearly of physiological importance to the plant, and both show strong dominance in the single factors responsible. Factors affecting effectivity response are in addition highly specific to particular strains and even variants in the bacteria. These facts have an obvious bearing on the theory of natural selection as affecting the partners in a symbiosis, and also on clover breeding.

On the practical side it has been shown that with a strain of bacteria which normally gives a response intermediate in effectivity towards plant material of mixed genetical constitution, selection to increase the effectivity response is possible; but so far selection for responsiveness to native totally ineffective strains of bacteria have been unsuccessful, so that the problem of these strains must seemingly be dealt with from the bacteriological side.

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WILLIAM GREGORY, M.D., F.C.S.: 1803–1858

By G. COLMAN GREEN

FROM 1790 onwards, for a period of thirty-one years, James Gregory, M.D., occupied the chair of the practice of physic in Edinburgh, whence he conducted a ruthless assault upon disease by bloodletting, cold affusion, brisk purging, frequent blistering and vomiting with tartar emetic. In "Conspectus Medicinæ Theoreticæ" he summed up his aggressive philosophy and epitomized medical practice and the knowledge of therapeutics of the time. For decades this work remained a standard for its medical content and for the purity of its Latin. In 1773, his father, occupant of the chair before him, had died. Young James, a student of nineteen, leapt into the breach and completed his father's course of lectures with such success that a chair was kept open for him until he had appropriately qualified and reached an acceptable maturity at the age of twenty-three. His gargantuan vigour projected across a century and a half one of the most prescribed medicaments in the Pharmacopœia, his "Gregory's Powder", a mixture of rhubarb rhizome, ginger, and magnesium carbonate.

> "If in doubt 'lead with trumps' is counsel so old,
> As never to fail with a game in a fixture,
> And medical men, in their doubt, I am told
> Are safe when they lead with *Gregory's Mixture*."

James took up residence in his deceased father's house at No. 15 in the windy, grey, romantic Canongate; but later, in 1796, he moved to the more fashionable St. Andrew's Square to raise his numerous family at No. 2. Three of his children attained high distinction. James Crawford, his eldest son, a physician of great promise, qualified M.D. at Edinburgh and died shortly afterwards from typhus contracted in general practice. Of Duncan, mathematician and fellow of Trinity College, Cambridge, Lord Kelvin said at the British Association meeting in 1898: "Gentlemen, Gregory died too soon. We cannot tell

what we might have known had Gregory lived". William, the chemist, struck devastating blows in the war with pain, and, dying at the age of fifty-four, was honoured with a remarkable display of civic affection in the shape of a public funeral.

William was born in December, 1803, survived a not too robust childhood and youth and was carried by the impetus of family tradition to graduation in medicine at Edinburgh in 1828. His health is said not to have been improved by poring over chemical experiments, and a fever in 1826, in which he nearly died, left him with an increased degree of incapacitation for the rest of his life[1].

Having graduated in medicine, William promptly abandoned it for his first love, chemistry, and it is not to be wondered at if this eventually carried a medical bias. As a physician, his father is said to have enjoyed the most extensive and lucrative practice in Scotland, and it is to be presumed, therefore, that funds were not lacking for William to pursue his study of chemistry on the Continent, as was then the fashion. Working with Justus Liebig at Giessen, the foundations of a life-long friendship were laid, and it was Gregory who introduced Liebig to the English-speaking world by translating his works into English.

Returning to Britain, Gregory embarked upon a tour of academic appointments, becoming successively extra-academical lecturer on chemistry at Edinburgh; professor at the Andersonian College, Glasgow (1837), where he succeeded Thomas Graham[2]; lecturer in Dublin University Medical Schools; professor of medicine and chemistry at King's College, Aberdeen (1839); and, finally, at Edinburgh (1844) he was elected to the chair of chemistry, which he occupied until his death. In these appointments he became the sixteenth of the "Academic Gregorys" to hold a Scottish professorship[3], an achievement in inherited scientific talent for which Francis Galton enshrined them in "Hereditary Genius".

Gregory's best work was accomplished before he left Aberdeen at the age of forty, by which time his health was so impaired that many thought he was unfit to take up the professorship at Edinburgh. With the passage of time his interests became progressively sedentary in character and culminated in microscope studies of Diatomaceæ, with the results of which the memoirs of the Royal Society of Edinburgh were enriched.

As a teacher and author, Gregory established a reputation in his own right which owed nothing to family tradition or glamour, and it was at Aberdeen that he reached his zenith in these spheres[4]. His teaching was summarized in his "Outline of Chemistry", first published in 1845, soon after he had settled in Edinburgh[5]. In its own sphere the volume attained a reputation equal to that of his father's "Conspectus" and it was notable for its propagation of Liebig's views, especially those concerning compound radicals.

Gregory was quick to see the dependence of national prosperity on chemical research. He protested that there was, at the time, no laboratory in Great Britain where practical chemistry could be taught and research carried on. Since, it appeared, the universities had insufficient resources to establish and maintain such laboratories, he urged that an inquiry should be made into the possibility of establishing research schools in chemistry in British universities with Government funds[6]. He protested against the situation in which nearly every British chemist of standing of his day had been trained at Paris, Berlin, Göttingen or Giessen.

Fifty-three publications are credited to William Gregory[7], the range of subjects of which show him to be something of a scientific dilettante. On May 11, 1841, three years before he left Aberdeen, Gregory presented a paper to the recently formed Chemical Society of London "On a Simple and Cheap Method of Preparing Hydrochloric Acid Absolutely Pure, and of Any Required Strength"[8]. He was rewarded with election to the fellowship of the Chemical Society precisely one week later. But two further contributions in the realm of practical chemistry have had an insufficiently recognized effect on human welfare. The one referred to the purification of anæsthetic chloroform and the other to the manufacture of pure salts of morphia. Both contributions ultimately were concerned with the relief of pain, and, in order properly to assess their importance, it is necessary to consider them briefly against the contemporary social and scientific backgrounds.

At the turn of the century the problem of pain, especially in surgery, was deeply exercising the minds of men. It is not difficult to understand Gregory's concern with the problem when it is remembered that his heredity, training, environment and health conspired to turn his interests in that direction. Prior to the introduction of anæsthetics in 1847, surgery was synonymous with butchery except where, latterly, patients had been operated upon in a 'magnetic sleep' as the hypnotic trance was then called. Recamier first operated on a patient in a 'somnambulistic sleep' in 1821, a decade before chloroform was first isolated. The technique was much practised at the Hôtel-Dieu and Salpêtrière in Paris. In Britain, Elliotson, professor of the theory and practice of medicine in the University of London, operated upon patients in a hypnotic trance at University Hospital in 1837 and lost his appointment for persistence in his unorthodoxy. It was Mesmer, of course, who first fell upon the phenomenon of hypnotism about 1774, but who, like many who followed him, missed the psychological shadow in postulating the existence of an æthereal substance—a sort of universal conducting fluid—which was believed to be the effective channel of communication between patient and 'magnetizer'. 'Animal magnetism', as it was then called, caught the imagination of the Western world, and upon Mesmer's original observations was built a top-heavy structure, embellished by every conceivable type of charlatanism, which defeated attempts at demolition by successive commissions of investigation set up by the French Academy during a period of decades. It is not surprising that animal magnetism caught Gregory's attention on his Continental visits and that he was ultimately led in 1851 to produce a treatise on the subject[9]. In this book Gregory drew conclusions which were unsupported by experimentally determined fact, and he developed a theory concerning the 'higher phenomena' which his critics did not hesitate to describe as dabbling in the occult. Sir Robert Christison, the great toxicologist, summed up his colleagues' attitude towards Gregory's activities in this direction in the following terms:

"Dr. Bennett gave an admirable lecture . . . on the rational view to be taken of . . . mesmerism . . .; and in the course of it he pounded satisfactorily Dr. Gregory, who always sits in the front seat of every concert, opera, lecture, or public spectacle, but found his favourite position a very hot and uneasy one for once in his life. . . . I was not present,

thinking it a shame to encourage in any shape the Professor of Chemistry in making a donkey of himself and a laughing stock of the University."[10]

At a later date even the elegant *Scotsman*, in its otherwise laudatory obituary notice[3], gently reproached the dead Gregory for his credulity in associating himself with such matters, thus endangering his own reputation and embarrassing his friends. Such, then, was the highly emotionally toned setting in which Gregory conducted his more mundane investigations in practical chemistry.

In 1849, five years after elevation to the chair of chemistry at Edinburgh, Gregory published "Notes on the Purification and Properties of Chloroform"[11]. Chloroform was first prepared independently by Soubeirian (October 1831) and Gregory's friend Liebig (1832). David Waldie, a Linlithgow surgeon-apothecary, directed the attention of Sir James Young Simpson to its anæsthetic properties, and it was Simpson who firmly introduced it into medical practice by 1847. Edinburgh manufacturers were, at that time, quick to co-operate in the development of medicinal chemicals, the recognition of which, or the elaboration of technique in the use of which, resulted from the wave of scientific discovery and advance emanating from the medical schools of the City. Foremost among these manufacturers was J. F. Macfarlan, a surgeon-apothecary, who had been admitted to the fellowship of the Chemical Society a few weeks before Gregory's election in May 1841. Macfarlan counted among his honours the royal appointment as chemist to H.M. the Queen in Scotland and the presidency of the Royal Medical Society of Edinburgh. He was also baillie of the City and it is said that, in this capacity, he voted against the appointment of Simpson to the chair of midwifery at the University on the grounds that he was too young, and, in any event, unmarried. Macfarlan had established a business at 17 North Bridge in 1780, where he took into partnership David Rennie Brown as chemist and engineer; and it may be noted that Rennie Brown's descendants in the fourth generation actively control the business of Messrs. J. F. Macfarlan & Co. to this day. Macfarlan and his partner were soon meeting the demand for chloroform which Simpson's advocacy created, as also were Messrs. Duncan, Flockhart and Messrs. T. and H. Smith, all of Edinburgh, by 1848[12]; indeed these three Edinburgh firms remain among the major producers of anæsthetic chloroform at the present date. A little later London manufacturers entered the field, but so poor was the quality of their product that chloroform anæsthesia became discredited in the south of Britain on account of the vomiting, nausea and even the fatalities which attended its use. In the paper referred to, Gregory correlated the unpleasant side-effects with the presence of 'poisonous oils' which he found to be present even in the best chloroform, albeit in traces; but, when wood-spirit was used as a raw material—as it was by manufacturers in the south in place of the more expensive grain alcohol—the 'poisonous oils' were found to be present in very substantial quantities.

Gregory devised a simple method by which the physician could purify his own chloroform and thus avoid the undesirable effects. The method consisted of a series of washes with oil of vitriol, until no further darkening occurred, followed by a further treatment with oxide of manganese to remove any sulphurous acid formed. Suitably modified, the method was applied later on a manufacturing scale. However, it was not long before it was found that increasing purity was accompanied by increasing instability, with formation of carbonyl chloride. It was Macfarlan's partner, Rennie Brown, who consummated Gregory's work by finding in 1863 that the formation of carbonyl chloride was inhibited by the addition of a small quantity of alcohol[13]. The addition of alcohol to chloroform to confer stability has been officially recognized in the Pharmacopœia since the edition of 1867.

Gregory's contribution to successful anæsthetic chloroform manufacture was quite overshadowed by his discovery of a cheap method of manufacturing salts of morphia. The importance of neither of these developments, however, was sufficiently appreciated in Gregory's life-time, because, in the case of chloroform, the personalities of all other workers in the field was obscured by the personality of Simpson, and their achievements equally were obscured by the immediately spectacular benefits which Simpson's work bestowed on mankind; and, in the case of morphia, it can now be seen in retrospect that certain events had to occur during the twenty-four years subsequent to Gregory's discovery in this field before it could be developed to its full significance.

This work on morphia on which Gregory's fame in posterity mainly rests was accomplished in 1831, only three years after his graduation in medicine and immediate adoption of chemistry as a career. By the end of the eighteenth century attempts were being made to isolate the active principles of drugs, concentration having been achieved in some measure, long before, through various galenical preparations. The universal opium preparation was laudanum which Sydenham (1669) rendered palatable with clove, cinnamon, saffron and Canary wine. Robert Boyle, who was friendly with Sydenham and accompanied him on his visits to patients, tentatively turned his attention to the active principle of opium by treating the drug with salt of tartar (potassium carbonate) and then extracting with spirit of wine[14], but pursued the investigation no further. At the close of the eighteenth century the greater understanding of chemical principles and the increasing refinement of manipulative techniques were working a tremendous leavening. In 1803, the birth year of both Gregory and Liebig, Derosne isolated what was thought to be the active principle of opium; but the preparation later turned out to be chiefly of the base narcotine. Sertürner clarified the problem of the naturally occurring bases and, by 1816, morphine was given to medicine as that most difficult of its salts to prepare, the acetate. The cost of morphine may be imagined with opium, the raw material, coming out of the Near East at 36s. per lb. to the apothecary in 1819, and with grain alcohol as a process chemical at 11s. the proof gallon. Morphine acetate became available in Britain and came into use in medicine about 1823; but it was always contaminated with narcotine and was a brown, often tarry, mass. Moreover, unscrupulous Glasgow manufacturers were preparing morphine for the London market from "refuse of laudanum" (opium marc), which, of course, should have contained little or no morphine had the laudanum been properly prepared. This particular product, therefore, could only be regarded as a narcotine preparation with varying quantities of contaminating morphine depending in amount upon the efficiency with which the laudanum had been prepared. Consequently morphine therapy fell into disrepute in the south of Britain just as it has already been shown was to be

the fate later of chloroform anæsthesia for similar reasons and from similar causes.

Gregory's achievement, which he shared with Dr. Humphrey Robertson and with Dr. (later Sir Robert) Christison as clinician, was to devise a process of isolation and purification which enabled a dose of morphine to be prescribed in a great state of purity at no greater cost than an equivalent dose of laudanum. The process was simple once conceived. It was based on an observation by Wöhler and Wittstock, published in Berzelius's "Lehrbuch", that if hydrochloric acid were added to the alcoholic solution of morphine base obtained by Robiquet's method of preparation and the solution then evaporated, a mass of feathery white crystals of morphine hydrochloride was obtained. In "Gregory's process" in its original unmodified form, opium was exhausted with water, the extract concentrated, and the morphine base precipitated with ammonia. The precipitate was filtered, washed, dried and rubbed up with water. A slight excess of hydrochloric acid was added and morphine eventually crystallized out as the hydrochloride. This was the "Gregory salt" and was in fact a mixture of morphine and codeine hydrochlorides. Gregory did not recognize the presence of codeine as it was unknown until it was isolated by Robiquet a year later, he having found this new alkaloid as an impurity in morphia salts prepared by the "Gregory process". Three crystallizations of the "Gregory salt" gave a preparation of snow-whiteness which contrasted very favourably with the brown gummy acetate previously available.

The yield of morphine was poor; but so it was with any other available process. The principal losses were accounted for by failure to recover morphine from the mother liquors. But, in addition, the yields varied according to the source of opium. From East Indian opium Gregory obtained morphine hydrochloride in yield of 4·5 per cent by weight on the opium taken. Turkish opium yielded 10–11 per cent, while from "a very pure specimen of Mr. Young's British Opium"[15,16] Gregory obtained his best yield of 13·5 per cent nearly. The most important feature of the process was that the expensive alcohol required by alternative processes was dispensed with. Gregory calculated that, for twenty shillings, the apothecary should receive 1,700 doses of laudanum, or 1,840 doses of snow-white muriate of morphia.

In his paper "On a Process for Preparing Economically the Muriate of Morphia"[17] presented to the Royal College of Physicians of Edinburgh in 1831, Gregory stated that the new salt was on sale by Messrs. Duncan, Ogilvie and Messrs. Cheyne at the Edinburgh Apothecaries Hall. Clearly, such preparation as was then made must have been on a laboratory scale; indeed, a preparation made on such a scale, based on Gregory's process but with some modifications, was described in the Pharmacopœia up to and including the 1885 edition, after which the process of manufacture became optional and all that was required was that the product should conform with the standards laid down. The first national Pharmacopœia was published in 1863, previously to which pharmacopœias were issued in London, Edinburgh and Dublin. "Gregory's process" was adopted in the Edinburgh Pharmacopœia of 1839, and, as Dr. Christison, Gregory's collaborator in the clinical tests, was mainly responsible for the edition, this is not surprising. The London Pharmacopœia lagged far behind, preferring with the French Pharmacopœia the method of Robiquet; so that a reviewer of the new edition of the Edinburgh Pharmacopœia in the *Lancet*[18] initiated a revolt in the following terms: "We would strongly recommend those who have any regard for their pockets or for their credit as pharmaceutical chemists to consign to oblivion the London Process and to adopt that of Edinburgh despite the threatened tortures of Pall Mall".

There seems to have been no attempt by Gregory to protect or exploit his process, and it is almost certain that neither he nor his contemporaries fully appreciated its fundamental importance. The reason for this is easily seen. Paregoric and laudanum were firmly fixed in the public and professional minds as the traditional media for administration of opium alkaloids, and they had the merit that, accepting some variation in strength, their clinical characteristics were well known. Furthermore, there was, on Gregory's own costing, no markedly attractive financial advantage in the use of the pure morphia salt over laudanum. But, in 1855, Alexander Wood, another of Gregory's illustrious and contemporary fellow citizens, introduced hypodermic injection into general practice[19], and the future of pure morphia salts, which were essential to the technique, was secured. Thus twenty-four years had passed before the technique of administering narcotics was sufficiently developed to initiate a demand for pure salts of morphine in quantity. This demand was a first requisite in the intensive development on a commercial scale of "Gregory's process". Three years later Gregory was dead. Because of the delayed demand for pure morphia salts in anything like commercial quantities, it is easy to see why those who appraised Gregory's work upon his death placed wrong emphasis and valuations upon his achievements.

The business of Baillie Macfarlan and Rennie Brown had an established trade in laudanum, and it is of interest that de Quincey made his purchases of this drug during his sojourn in Edinburgh, at 17 North Bridge. Besides being fellows of the Chemical Society of London, both Macfarlan and Gregory were members, and, at one time or another, office-holders in learned societies centred in the Scottish capital. This personal and professional contact between Macfarlan and Gregory suggests the manner in which the gap was bridged between academic discovery and commercial development. It was Rennie Brown who was mainly concerned with the industrial development of Gregory's process, and J. F. Macfarlan and Co. were the first to manufacture pure morphine salts on anything like a commercial scale in Britain, commencing the manufacture during 1833. T. and H. Smith commenced the manufacture of opium alkaloids in 1837[12], and thus the manufacture of these alkaloids became established at Edinburgh, where it has been carried on by these two firms to the present time.

William Gregory was one of the lesser lights of chemistry; but, nevertheless, he occupies a uniquely focal position in a period of scientific discovery and of the first great developments in the practical application of organic chemistry. He was one of an important group of figures in a nineteenth-century vista of Edinburgh and was responsible for the linkage of many strands in a matrix of scientific endeavour centred in the City.

Gregory died at his home in Princes Street on April 24, 1858, in his fifty-fifth year and was buried in the family vault in the Canongate Churchyard. Towards Holyroodhouse, and just beyond a stone's-throw from his resting-place, stands a 'monument'

wherein morphia is manufactured to this day by a process originally based on that devised by him more than a century ago.

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CREEP OF METALS

AT a conference organised by Sir Charles Darwin, and held at the Royal Society on February 5, opportunity was given for physicists, engineers and metallurgists interested in the 'creep', or continuous slow deformation under load, of metals to compare their findings and express their several points of view.

It is well known that when a metal 'creeps' under constant temperature and load, the rate of extension at first decreases progressively, then remains constant for a period, and afterwards increases. Prof. E. N. da C. Andrade emphasized the complex nature of the processes involved, but maintained that for all pure metals below their recrystallization temperature range, the use of a constant stress in place of a constant load results in the elimination of the final increase of rate of strain, the creep then taking place according to the relation

$$l_t = l_0 (1 + \beta t^{1/3}) e^{kt},$$

where l_t is the original length, l_0 the length after time t, and β and k are constants. The constant β never rises above a certain value, and represents a type of transient flow associated with rotation of the crystals, while k represents a uniform rate of flow due to movement along the glide planes. The k flow is governed by an activation energy, analogous to that determining the rate of viscous flow of Newtonian liquids, so that, for varying temperatures, the rate of flow is proportional to $e^{-E/kT}$ (where E is the activation energy); but it differs from the viscous flow of liquids in that the activation energy is a function of the applied stress. In the case of single crystals, the activation energy takes the form

$$E = A (S_0 - gS)^2,$$

where S_0 is the critical shear stress necessary to cause glide in glide plane, S is the applied stress and g is a stress concentration factor. Consequently,

$$\text{creep-rate} = C \exp. \left[- \frac{A}{kT} (S_0 - gS)^2 \right].$$

This expression, which originated in a modification by Orowan of the theory proposed by Becker, has been confirmed for the creep of single crystals in cases where the stresses are not too big. The necessary activation energy is regarded as being supplied by thermal fluctuations and spans the gap between the stress necessary to cause slip S_0 and the stress gS present at points of stress concentration in the crystal.

Prof. Andrade emphasized the point that, with polycrystalline wires or rods subjected to tension at constant load and high temperature, the rate of flow may increase for two quite different reasons: (*a*) increase of stress, and (*b*) slow recrystallization processes. Flow (*a*) will take place with all metals if the extensions are large, say of the order 5 per cent or more: on the other hand, flow (*b*) will take place with certain metals, and not with others, and may occur even where the extension is a fraction of 1 per cent, and so the stress tolerably constant. The form of the curve of extension against time is similar in case *a* at many per cent, and in case *b* at much smaller extensions, although the physical processes are quite different in the two cases; this has led to much confusion, especially as to the necessity of maintaining constant stress. In case *b* the material at the end of the test is not the same as at the beginning.

Mr. H. J. Tapsell, after describing the methods employed at the National Physical Laboratory in testing the creep resistance of engineering materials, directed attention to the extreme slowness (of the order of 10^{-8} strain per hour) of the changes in which the testing engineer is interested, and showed the difficulty of expressing the behaviour of engineering materials in simple terms by quoting examples of unpredictable changes in creep-rate which may occur after long periods of test. These render long-time tests a practical necessity, and the problem of predicting safe ranges of stress for engineering components which must give satisfactory service for periods of many years is one of real difficulty. However, a set procedure of extrapolation from the behaviour during short periods at temperatures rather above the service temperature, combined with the judicious use of empirical formulæ for the variation of creep-rate with stress and time, often enables a practical solution to be found. The practical efficacy of these methods was confirmed later in the discussion by Dr. R. W. Bailey.

Provided tests are limited to the early stage of decreasing creep-rate, simple relationships of the type:

Creep-rate $= A$ (stress)^n (at constant temperature and time);
Creep-rate $= B$ (time)$^{-p}$ (at constant temperature and stress);

appear to hold for a variety of materials, and creep curves in tension, torsion and combinations of tension and torsion have the same geometric form. When the

test piece is unloaded, a slow recovery of dimensions follows the immediate elastic contraction, and is thought to be attributable to the strain concentrations between individual crystals during creep.

Dr. E. Orowan suggested a new theoretical approach to the problem of creep and of plastic flow in general. Sudden application of a stress produces a sudden plastic deformation, followed by creep at a rapidly diminishing rate. At the end of the sudden deformation, the resistance of the material to plastic deformation (its yield stress) is just sufficient to balance the applied stress if this is not helped by thermal stress fluctuations; the activation energy for creep at this moment, therefore, is vanishingly small. As creep proceeds, however, the yield stress rises owing to strain hardening, while the applied stress is kept constant. For relatively small creep strains, the rise of the yield stress is proportional to the creep strain γ, and so the additional stress that has to be supplied by thermal fluctuations in order to produce creep rises proportionally to the creep strain. If, as in the Becker theory, the activation energy is assumed to be proportional to the square of the activation stress, the frequency of local creep processes is proportional to

$$\exp. - n\gamma^2/T,$$

where n is a constant. If it is assumed that, with polycrystalline metals and single crystals of cubic metals, the contribution of a successful stress fluctuation to the macroscopic creep strain is inversely proportional to γ^2, the creep-rate is given by

$$\frac{d\gamma}{dt} = \frac{\text{const.}}{\gamma^2} \exp. - n\gamma^2/T.$$

Measurements of creep curves by J. Los in the Cavendish Laboratory were found to be represented by this formula with a high degree of accuracy.

If there is a noticeable recovery (thermal softening), the decrease of the yield stress due to this factor must be subtracted from the activation stress; after prolonged creep at not too low temperatures, this may become a dominating factor, and then the above formula goes over into the expression resulting from the well-known recovery theory of creep. The simple recovery theory, however, is unable to account for the slowing down of the creep in the initial stage. In its original form, the Becker theory is equally unable to explain the slowing down of the creep; if strain hardening is introduced into the Becker–Orowan formula, other difficulties arise from the circumstance that, according to experiments, the rate of creep is not uniquely determined by stress, strain and temperature.

Dr. Orowan mentioned that, according to his new theory, some characteristic features would be due to the circumstance that creep is distinguished from other known reactions by the increase of the activation energy during the reaction. The presence of vanishingly small activation energies at the beginning of the creep have received experimental confirmation by the observed creep of cadmium and zinc crystals at very low temperatures (down to 1·2° abs.).

A different and novel method of regarding the strain hardening was contributed by Dr. A. McCance, who related the hardening to the increase in volume which accompanies plastic deformation. By assuming that each element of slip along the glide plane is accompanied by a proportional separation at right angles to the glide plane, he showed that for an ordinary tensile test the stress should be related to strain by an expression of the form

$$S = Ae^{-\alpha x} \sinh \beta x,$$

where S is the stress, x the strain and A and α and β are constants; he demonstrated that if the contraction of area be used as the measure of strain, a value of β can be chosen for a variety of materials such that $\log S/\sinh \beta x$ gives a linear plot against x. The further assumption that when the metal is subject to continuous creep, the velocity of shear is proportional to the difference between the applied stress S and a suitably defined limiting shear stress S_0 led to an equation of the form

$$x = 2x_0\, e^{-\alpha t} \sinh \sqrt{\alpha^2 + \beta(S - S_0)}\ .\ t,$$

where x is the extension after a time t, x_0 is the total extension which takes place after an infinite time under the limiting stress S_0, and α and β are constants. It was then shown that change in the value of $(S - S_0)$ in this equation reproduces qualitatively the effect of changes of stress on the form of the creep curve, and that for certain creep curves values of $\sqrt{\alpha^2 + \beta(S - S_0)}$ could be chosen such that

$$\frac{x}{\log \sinh \sqrt{\alpha^2 + \beta(S - S_0)}\ .\ t}$$

gives a linear plot against t. Attention was directed to the possibility of deducing the value of S_0 from a few short-time creep tests, and of forecasting the conditions under which the inflexion in the time-strain curve which precedes fracture would occur. These predictions would naturally be subject to the condition that the metallurgical structure of the material remains constant over the times under consideration.

The influence of metallurgical structure was dealt with briefly by Dr. N. P. Allen, who, after pointing out the increasing need for the development of metals capable of serving at much higher temperatures than have hitherto been used, described the phenomena of which advantage is taken in producing creep-resistant alloys. Increasing the grain-size of the material improves the creep resistance, but is attended by certain disadvantages, and reliance is placed more commonly on the addition of elements which raise the softening temperature of the material, or produce precipitation-hardening effects. There is a close correlation, which probably is significant in relation to the theory of creep, between the effect of added elements on the creep resistance of metals, and the effect of the same elements upon the softening temperature, that is, the temperature at which the additional hardness produced by cold deformation of the metal is removed. The addition of elements which raise the softening temperature, combined with the judicious use of work hardening, is an effective method of improving creep resistance. Precipitation hardening can also be effective, but the relation between the hardening process and the improvement of creep resistance requires further study. Not every alloy which hardens well has good creep resistance; and, in alloys capable of high creep resistance, the heat treatments which produce the greatest hardness do not necessarily produce the best creep resistance. The compositions and heat treatments which give the best results are much influenced by the service temperature, and the form of the solubility curve of the precipitated constituent has an important bearing on the behaviour of the alloy. The creep resistance of certain alloys is also profoundly influenced by small additions made during the deoxidation process, and these additions need to be carefully controlled if uniform results are to be

obtained. Explanations of these phenomena, which are technically extremely important, are in many cases lacking.

The general discussion was opened by Sir Lawrence Bragg, and divided itself broadly into suggestions and speculations on the part of those who wished to reduce the creep phenomena to simplicity, and warnings—most of them from the engineers and metallurgists—concerning their essential and extreme complexity. In the first class, Dr. McCance's contribution has already been described. Sir Lawrence Bragg suggested reasons for Dr. Orowan's assumption that the magnitude of the movement accompanying each slip is inversely proportional to the square of the preceding strain, and referred to the possibility of a type of movement in the grain boundaries which is not accompanied by any increase of the resistance to further movement.

Many examples of the unexpected influence of certain factors on the creep strength of metals arose. Dr. L. B. Pfeil described the tenfold superiority of cold-drawn sintered platinum over similarly drawn cast platinum, which superiority, however, is displayed only if the sintering is not carried out at too high a temperature. Dr. C. J. Smithells directed attention to the marked influence of impurities in tungsten and nickel chromium alloys at high temperatures, which led him to think that the grain boundary at high temperatures is a seat of peculiar mobility; and Mr. E. H. Bucknall to the superior creep strength of the so-called 'intermediate structure' of alloy steels, which is usually regarded as somewhat inferior in general mechanical properties to the conventional quenched and tempered structure. Mr. D. A. Oliver showed how the creep strength of certain alloys is significantly influenced by the temperature at which the final stage of work hardening is carried out. Dr. R. W. Bailey referred to the importance of progressive softening of the metal during the creep test, which proceeds more quickly in heavily cold-worked than in lightly cold-worked material, and accounts for the inferiority of cold-worked material at high temperatures. Sir Charles Darwin questioned whether the creep is in fact continuous with time, eliciting the information that discontinuous creep has been observed on several occasions; and Mr. C. G. Conway referred to the important point that the imminence of fracture cannot be deduced from the rate of creep.

No summing up of the discussion was attempted, but the writer might venture one general impression —that of the unreliability of the too exclusively mathematical approach. It is simple to arrive at a formula which shall predict, with fair accuracy, an observed behaviour; but it is another matter to demonstrate that the processes assumed in the derivation of the formula are actually going on in the metal.

N. P. Allen.

OBITUARIES

Prof. V. Dolejšek

The death of Prof. V. Dolejšek in January 1945, after much suffering, deprived Czechoslovakia of one of its most outstanding men of science. Dolejšek was a distinguished experimental physicist and X-ray spectroscopist. Born on February 20, 1895, in Prague, he studied at the Charles University, where he obtained his doctorate in 1919. In 1922, he worked with Prof. Manne Siegbahn in Lund, and later with Prof. Paschen in Tübingen. In 1928 he was made a temporary professor and in 1935 a permanent professor of experimental physics at the Charles University, Prague.

Dolejšek's scientific career started in the laboratories of Prof. Siegbahn. As a result of his extraordinary experimental skill, he attained an accuracy of measurement of X-ray wave-lengths which has scarcely been surpassed by more elaborate modern methods. In 1922 he discovered the first lines belonging to the *N* series of uranium and thorium, and later two lines of bismuth. This important discovery contributed substantially to the development of the Rutherford–Bohr–Sommerfeld theory of atomic structure. This work is noteworthy for its experimental difficulties. The lines were measured in the long-wave region 8–13 A., whereas the longest wave-lengths previously measured were about 5–7 A.

Dolejšek realized that Moseley's law is only approximately valid and that there exist fluctuations in the function connecting atomic number and frequency of X-ray absorption edges and emission lines. He discovered that these fluctuations have the same periodicity as the periodic system of the elements, and he deduced very accurate empirical laws for the deviations. He also studied the dependence of these fluctuations on the valency, and discovered a law which is the only general law known to be valid in the intricate system of relationships between all of the relevant factors. He also studied the fine structure of the absorption edges and thus verified the theory of Kronig.

These investigations required many measurements of X-ray lines, and several of his papers are concerned with new discoveries and precision measurements of diagram and non-diagram X-ray lines. The highest accuracy was always attained by comparatively simple means. The long-wave region of X-rays was always Dolejšek's favourite, and he designed and constructed an extremely efficient high-intensity X-ray gas tube for very low voltages of the order of a thousand volts, in conjunction with a vacuum spectrograph, which was used to explore this inaccessible region between X-rays and ultra-violet rays. He employed either plane or concave gratings used at a total reflexion angle, or suitable organic or inorganic crystals. A new focusing method with a bent crystal was devised in his laboratories, which has a very high resolving power and yet requires short exposures. This enabled him to measure many spectra of solid elements and of gases, and to contribute further to our knowledge of the *N*-series. In addition, he studied the resolving power of gratings and crystals, the reflecting power of crystals and their surface structure, penetration of X-rays into crystals and many other related problems.

Later Dolejšek extended his spectroscopic work into optics. Optical absorption spectra of rare earths in solutions were studied by means of a powerful hydrogen tube, and the solvent effect investigated. He demonstrated thus that the optical electrons of rare earths are 4*f* electrons inside the ions. His success in spectroscopy was largely due to his great knowledge of vacuum technique, for which he developed powerful condensation pumps working with solid paraffin, oil manometers for measurement of very low pressures, variable precision gas leaks and many other devices. His knowledge was also of greatest value to the industry. He collaborated with the Škoda Works on many problems, such as vacuum

evaporation of metals, magnetic crack detection, high-speed oscillography, electron diffraction, Geiger counter spectrographs, etc.

Dolejšek was popular with students, and collected around him a school of many young workers. Much of his work was published in *Nature*. In all, he produced more than sixty scientific papers.

The War and the closing of the universities of Czechoslovakia by the Germans meant for Dolejšek new and dangerous duties. He devoted himself to the work of an illegal group, which substantially contributed to the Allied victory. He worked on building a secret wireless station known as *L* 16. The leaders of the group fell one by one into the hands of the Gestapo, and he eventually became the leader; but he also was captured and died in the hands of the Germans at the Terezín concentration camp after much suffering, but unbeaten in spirit. He did not desert his cause, for which he fought to the end.

VLADIMIR VAND.

Mme. H. Metzger-Brühl

WE regret to record that the death in the extermination camp at Auschwitz must now be presumed of Madame Hélène Metzger-Brühl, a learned historian of science and treasurer of the Académie Internationale d'histoire des Sciences. Born in 1889 at Chatou (Seine et Oise) she graduated at the Sorbonne, specializing in crystallography and general chemistry. Her husband, Paul Metzger, professor of history at Lyons, as well as her eldest brother, fell in action in the First World War, and her younger brother, Francis, died in 1941. Thus of these gifted brethren the only survivor is M. Adrien Brühl, of the French School of Archæology at Rome.

Hélène Metzger turned early to the study of the history and philosophy of science. She was an active member of the Section d'histoire des sciences of the Centre internationale de Synthèse in Paris. When the Académie Internationale d'histoire des Sciences was founded in 1928 as the organ of the International Committee for the History of Sciences, Hélène Metzger's name was fourteenth on the list. In 1931 she succeeded Prof. Sigerist as its treasurer. In 1934, after the Nazi dismissal in Germany of Jewish members of the Academy, a large group of members led by the president of honour, Sir Frederic Kenyon, announced that in no circumstances would they attend a congress in Germany. Hélène Metzger was among those who initiated this decision and was marked for vengeance. After the German occupation of France the Gestapo tracked her from her home in Paris to a little *pension* at Lyons where she was writing hard. She was carried off to the fortress of Montuc and thence to the concentration camp at Drancy. Fellow victims who have survived testify to her courage and cheerfulness during these months. She was one of a convoy taken from Drancy to the extermination camp at Auschwitz.

Of Hélène Metzger's books, the best known are "Les Doctrines chimiques en France du début du XVIIe à la fin du XVIIIe siècle", and "Les concepts scientifiques", both of which were *couronné*—the former by the Paris Academy of Sciences while the latter won the *Prix Bordin* of the Academy of Moral and Political Sciences.

"Les concepts scientifiques" is perhaps her most striking contribution. Contemplating—to use a phrase of M. Lalande who contributes a preface to the published volume—"the natural history of scientific thought", she analyses the parts played respectively by analogy; by concepts of permanence (conservation) of matter; by concepts of evolution, parallel, divergent or convergent; and by what she terms scientific nominalism, leading to abstractions by elimination (*épuration*) or by indetermination.

Her most important evidence for building the 'natural history' is taken from the field of seventeenth and eighteenth century chemistry, which she had made peculiarly her own. While earlier thought, of course, contributes illustrations to the section on analogy, the emphasis is on those to whose writings we can turn to test the classification proposed, and this enhances the value of the study.

A stream of historical studies mostly contributed to *Isis* or to *Archeion* followed this volume. Hélène Metzger was always concerned in tracing the psychological implications of the growing body of scientific knowledge. She was no less steadfast when the question of principle arose as regards relationship with the Nazi Government. In her last hours there must have echoed in her mind those words of another such victim, "Perhaps ye who sentence me are more fearful than I".

CHARLES SINGER.

NEWS and VIEWS

Dr. R. J. W. LeFèvre

DR. R. J. W. LEFÈVRE has been appointed to the chair of chemistry in the University of Sydney, which will become vacant shortly through the retirement of Prof. C. E. Fawsitt. Dr. LeFèvre is at present head of the Chemistry Department of the Royal Aircraft Establishment, Farnborough, and hopes to take up his new post during the latter part of this year. Educated at East London (now Queen Mary) College, Dr. LeFèvre was appointed a lecturer at University College, London, in 1928, becoming later reader in chemistry of the University of London. During the whole of the War he has been with the Air Ministry and Ministry of Aircraft Production. In 1941 he went as chemical adviser to the Commander-in-Chief Far East, with headquarters in Singapore. He fortunately escaped, not without difficulty, and on arriving in Australia took up a similar appointment with the Royal Australian Air Force. He returned to England in December 1943 and later was appointed to Farnborough. In his research work at University College, Dr. LeFèvre applied physical methods to organic chemistry problems. His most important work has been in the use of dielectric constant measurements to solve numerous difficult geometrical structural problems such as the identification of *cis*- and *trans*-forms. The method was also used for following reaction velocities. His wife, Catherine LeFèvre, was associated with some of this work, and she also carried out independent studies on the related phenomenon, the Kerr effect. During the War, Dr. LeFèvre's work ranged over the whole

field of chemistry—physical, analytical, organic, etc.—and his work made a notable contribution to the war effort. His appointment to Sydney will play an important part in the continuation of the close links which have for long existed between the universities of Great Britain and Australia.

Institute of Fuel : Appointment of New Secretary

MR. P. C. POPE, who has been secretary of the Institute of Fuel from its earliest days, resigned on March 1 and will in future act as adviser to the Institute. In token of the energy and enthusiasm which Mr. Pope has always devoted to the Institute of Fuel, and to fuel technology in general, the Council of the Institute has unanimously recommended him for election as an honorary member.

Mr. R. W. Reynolds-Davies succeeds Mr. Pope as secretary of the Institute. Receiving his technical education at University College, Cardiff, and the South Wales School of Mines, Mr. Reynolds-Davies has had wide experience as a chemical engineer and fuel technologist. His first industrial experience was obtained on the coke-oven plant of the Cambrian Combine, now merged with the Powell Duffryn Associated Collieries, Ltd. He was later engaged as assistant with the late Dr. W. R. Ormandy on power alcohol and petroleum products. This work was followed by nine years as one of the chemical plant managers with British Industrial Solvents, Ltd. For the three years previous to his joining the Institute of Fuel last autumn as deputy secretary, he was manager of the Development Department of the Royal Ordnance Factory at Bridgend.

A Radiochemical Laboratory at the University of Durham

SINCE the early days of radioactivity, successful research in this field was frequently based on collaboration between physicists and chemists. In Great Britain, however, in the years between the two World Wars, the fundamental work done on the physical side of radioactivity, mainly by Rutherford and his school, was not adequately supported by chemical research on a similar scale ; nothing was attempted comparable to the continuous efforts in Paris (Laboratoire Curie) or Berlin (Kaiser Wilhelm Institute, under Otto Hahn) which, among other important results, led to the observation of the fission of uranium. As in the new phase of radioactivity inaugurated by this discovery the need for scientific workers trained in the chemistry of the radio-elements is even more obvious, the Council of the Durham Colleges, aided by the University Grants Committee, has recently decided to create the necessary facilities by founding a Radiochemical Laboratory.

The purpose of this Laboratory will be twofold. By incorporating a special course in radiochemistry into the curriculum of the Durham students of chemistry, it is intended to make them sufficiently well acquainted with up-to-date knowledge and apparatus to enable them to act at least as chemical helpers in the various radioactive research centres and plants now about to spring up in Britain. Further, by undertaking chemical research connected with radioactivity, it is hoped to contribute also to the progress of radiochemistry in the broadest sense of the term ; micro gas-analytical methods, the development and use of which have formed a feature of Durham chemical researches during recent years, will naturally be linked up with this programme. The Durham Radiochemical Laboratory will, at the beginning, consist of two small buildings, separate from each other and from the main Science Laboratories, for the treatment of feebly, and of strongly, radioactive substances, respectively. Their erection is under way and will be completed before the autumn, when it is hoped to open them not only for Durham students, but also for a small number of advanced workers. They will form part of the Chemistry Department of the University, under the directorship of Prof. F. A. Paneth.

Fisheries Laboratory, Lowestoft

ALTHOUGH three members of the staff of the Fisheries Laboratory, Lowestoft, who were acting as coastal fishery officers, succeeded in making scientific observations which have given valuable information on the war-time recovery of fish stocks, all co-ordinated scientific work at the Laboratory was suspended during the War. The Laboratory reopened in September 1945, when ichthyometric work on the chief food fishes and age-composition observations on the North Sea plaice and herring were resumed at the appropriate ports of landing. Plans for work in the waters around the British Isles and in the Arctic fishing grounds are in active preparation. These include the construction of a new laboratory, the building of a large research ship of the type used by the Hull trawler owners for the prolific Arctic fishery, and the conversion for research work in the North Sea of the Admiralty trawler *Sir Lancelot*, built during the War on the model of a successful commercial type—the *Star of Orkney*. In the meantime, a 90-ft. motor fishing vessel of a class built by the Admiralty with a view to subsequent use as fishing boats has been borrowed and converted to carry a trawl on the starboard side. This vessel is to be known as the *Platessa*. While her main task will be to mark large numbers of plaice in the southern North Sea so as to obtain vital information on the yield of the stock at the present rate of fishing, it is also hoped to gain information on the suitability and efficiency of this type of craft as a commercial trawler.

Technical Education in Great Britain

IN his reply to a lively debate on technical education in the House of Commons on March 22, the Parliamentary Secretary to the Ministry of Education, Mr. Hardman, stated that the national council for technology which is to be established to co-ordinate the work of the regions and ensure that a comprehensive national view is taken, as soon as the regional councils have been set up, will be expected to determine the question whether the technical colleges should award a diploma or a degree, which was left undecided by the Percy Committee. The Ministry has also in preparation a circular proposing to local education authorities the establishment for the major technical colleges of strong governing bodies representative of industry and of the authorities, and which should possess considerable executive freedom. Discussions are also proceeding with the various industries for the establishment of national colleges ; but Mr. Hardman's announcement that one has recently been established for watch- and clock-making will scarcely be reassuring to a body of opinion—which found admirable expression in the debate—holding that the real function of technical education is the creation of adaptable interest and intelligence.

and not the mere imparting of mechanical aptitude for any particular process. Mr. Hardman said further that the Ministry, after discussions with the Department of Scientific and Industrial Research and with the Federation of British Industries, is also seeking to encourage and considerably extend research work in technical colleges, and particularly research work which is directed towards the assistance of local industries.

In reply to questions about the disposal of scientific apparatus and other Government surplus stores, Mr. Hardman said that the Ministry is working in co-ordination with Government Departments selling surplus stores, and has its own representatives on the appropriate committees. The use of surplus stocks for the purposes of technical education has not been overlooked. Although the debate centred largely around the Percy Report, and it was admitted that the technical colleges and institutions of Britain should be developed so as to provide for a much bigger percentage of the school population, the question of technical education in relation to the universities was not pursued, and it is a sad reflexion on departmentalism that Mr. Hardman was unable to reply to numerous questions about the position of the universities, because they come more within the purview of the Treasury than of the Ministry of Education. Mr. Durbin's request that the Parliamentary Secretary should satisfy himself that the Ministry has communicated to the universities with sufficient clarity and force the essential need which the universities can meet in technical education, and that the universities are fully aware of the extent of that need, was virtually unanswered.

Seismic Sea Wave of April 2

On April 2 a strong tunami, beginning near Unimak in the Aleutians, ranged the Pacific Coast of the Americas and the Pacific Islands to distances of 7,000 miles. At Scotch Cape Lighthouse, near Unimak, it is reported to have attained a height of 100 ft. and to have killed ten people there. The effects were probably greatest at Hilo, Hawaii, at a distance of some 2,040 miles from Unimak Island. This town, with a population of 22,000, was devastated by at least three waves four to six feet high travelling at some 30 knots. Buildings on one side of Kamehameha Avenue were flung against those on the other side. In the town, sixty bodies have so far been recovered and twenty-three in the rest of the Hawaiian Islands. It is feared that the death-roll may reach 150, and damage is estimated at £2½ millions. At the time of the disaster, there were two ships in the harbour; one managed to put to sea, but the other, a freighter, was tossed up on the beach. The wave was less strong along the Californian coast, and in the neighbourhood of Arica and Iquique (Chile) it caused some apprehension. During the 24 hours following the Unimak earthquake, there were five strong aftershocks and forty or fifty smaller ones from the same or nearby epicentres.

Tunamis are often caused by the sudden rising or falling of a part of the ocean bed at the time of an earthquake. They are scarcely recognizable out at sea, but on reaching the head of a bay or harbour attain extraordinary heights, sometimes up to 100 ft. The outstanding feature of a tunami is its great wavelength—in the Pacific, 100 to 1,000 km.—and this explains the great distances such waves travel since the wave energy does not decline so rapidly as in ordinary wind waves. The principal period of the Sanriku tunami of June 15, 1896, was 15 minutes, and those of the Krakatoa eruption of August 27, 1883, one hour. The velocity of propagation is related to the depth of water through which the waves pass. The speed across the Pacific is about 450 miles an hour, and across the shallower Atlantic Ocean about 200 miles per hour.

Night Sky in South Africa

Dr. Mary N. Fysh, of "Canterbury", P.O. Devondale, Cape Province, South Africa, has sent an account of the night sky as seen from the high veldt country formerly known as Stellaland, in the Vryburg district of South Africa. There are probably few regions in the world better suited for such observations. Dr. Fysh states that the lightest film of cloud, such as will not hide even the faintest stars, is enough to obscure some of the appearances which she describes. Most of these will be recognized by astronomers and meteorologists as examples of the aurora, and a few perhaps refer to noctilucent clouds high up in the stratosphere.

Dr. Fysh writes: "On every clear night, soon after the brightest stars have appeared, on looking attentively straight overhead, one can see a fine pattern as if formed by tiny cloudlets, very delicately rose-coloured against the evening blue. Sir John Herschel, who noticed what seems to be the same appearance on the great nebula in Orion, describes it as 'like the breaking up of a mackerel sky'. The pattern gradually spreads outwards, around and downwards, until eventually the whole sky is encanopied as it were, the mottling being as a rule larger and more spaced out as it nears the horizon, and the colour changing from rose to lilac, then to lavender-grey or neutral against the pale primrose in the west where the sun has gone down. A little later, the zodiacal light interposes its softly glowing white, or faintly violet, pyramid between one's vision and the pattern, which is still to be seen overhead and in the eastern and southern sky. Sometimes, however, when the zodiacal light is less bright, both may be seen simultaneously, causing an observer to wonder whether the zodiacal light is seen through the pattern, or the pattern through the light. But we have only seen it thus on one occasion. As one watches, the pattern can often be seen to change a little, the mottling moving apart and closing up, as if blown hither and thither by some mighty wind, yet the whole held together in much the same delicate pattern. It is not always the same colour. As the night advances, the rose colour fades into lilac, then to a faint neutral or pearly grey. Or occasionally it is seen a quite deep red, against a dark, blue-black background. When this happens, it is striking enough to call forth exclamations of wonder from a casual observer, the red being very noticeable. The phenomenon is best seen out on the open veldt, far from the atmosphere of towns. There it can be studied at leisure, and its varying appearances under different conditions noted and recorded. Thus on moonlight nights the colour varies from pearl to silver, though then the rose colour may also sometimes be seen at its best; while under the mighty arch of the Milky Way we have seen it looking like myriads of soft snowflakes, so that one almost thinks there is a snowstorm going on up there."

Journal of Polymer Science

A PERUSAL of any of the published journals dealing with chemical and physical researches reveals an increasing number of papers devoted to matters concerning high polymers. Before the War, the tendency was not specially marked, but in the past seven years the growth of the purely academic side of the subject has increased significantly. This high-polymer chemistry might normally be regarded as a branch of classical colloid chemistry; but it has now outgrown this field and deserves a place of its own in chemical literature. To cater for those who wish to publish and to read recent advances in this relatively new branch of chemistry, a new *Journal of Polymer Research* has just made its appearance. It is published by Inter-Science Publishers, New York, and edited by P. M. Doty, H. Mark and C. C. Price, who will no doubt ensure that the quality of the papers submitted will reach a high standard. Similar ideas were in the minds of the Elsevier Co. of Amsterdam, and plans had actually been made to issue another journal on polymer science edited by R. Houwink. It is to the credit of both these publishers that they have seen their way to amalgamate the two journals, the editorial boards having joined forces in this international experiment. The subsequent issues will be under the title of *Journal of Polymer Science* published jointly by Interscience and Elsevier. The first number of the journal contains original papers by Huggins, Mark, K. H. Meyer, C. C. Price and others well qualified to write on matters concerning high polymers. If the standard of the first issue is maintained, there is little doubt that the journal will become a recognized medium for reporting on advances in high-polymer research.

Restoration of Science in Austria

A LEAFLET on "Science in Austria", presented on the occasion of the meeting of British men of science and the Association of Austrian Chemists, Engineers and Scientific Workers in Great Britain in support of the restoration of science in Austria, on November 3, 1945 (see *Nature*, Jan. 12, 1946, p. 53), includes a survey of the present position (from the Association, 133 Hatherley Court, London, W.2. Pp. 28). It refers to material destruction due to the War—heavy damage to the main buildings of the University in Vienna, the loss of a large part of the books of the University Library, and the total loss of the Institute of Experimental Biology are mentioned —and of moral devastation due to Nazi rule and resistance to the Germans in the universities. The Provisional Government and the Secretary for Education are attributing the greatest importance to repairing the intellectual damage of seven years of Nazi rule. A short survey of past scientific achievements in Austria gives an impressive picture of our debt to Austria in physics, radioactivity, chemistry, zoology and botany, even in the difficult period through which this small and impoverished country passed between the world wars. The concluding part of the pamphlet, "What Austrian Scientists Desire", expresses a hope for early restoration of contact between Austrian and Allied men of science, and includes a note by Emil Abel on the pioneers of physical chemistry in Austria, a tribute by F. Eirich to the work of H. Mark and W. Pauli, sen., in colloid chemistry, and other notes on Austrian work by L. Janossy (on cosmic rays), St. Jellinek (electro-pathology), H. Steiner (physical chemistry) and K. Weissenberg (on Guido Holzknecht's work on the application of X-rays to medicine).

Blindness of the Newly Born

EVERYONE who is interested in the welfare of the young, especially those who are interested in the prevention of blindness or impaired sight in the newly born or very young, should read the monograph entitled "Ophthalmia Neonatorum", by Prof. Arnold Sorsby (Institute of Ophthalmology Monographs No. 1. Pp. 1–66. London: Hamish Hamilton Medical Books, Ltd., 1945.) A note on his views on the world-distribution and causes of blindness in young and old alike has already been published in *Nature* (153, 383; 1944), and Prof. Sorsby has since supplemented them by a striking article on blindness in the British Commonwealth (*Brit. Med. J.*, 557, Oct. 27; 1945). In the present monograph he summarizes existing knowledge on one aspect of the general problem of blindness and impaired sight, but it is an aspect which is of very great importance. If his monograph suggests that impaired vision and blindness due to ophthalmia in the newly born is, as Sir Allen Daley says in his foreword, "well on the way to extinction", it also suggests that ophthalmia of the newly born is possibly "no less frequent to-day than it was 25 or 40 years ago". The statistics published in the monograph certainly leave no cause for complacency, although the results of compulsory notification and treatment, notably treatment with sulphonamides and penicillin, have been so remarkably good. The use of penicillin in ophthalmology is discussed in a leading article in the *British Medical Journal* (17, Jan. 5; 1946). Sir Allen Daley says that no preventable case of blindness should occur, and those who are familiar with recent developments in ophthalmology will agree that vigorous efforts are being made to attain this ideal.

Polarographic Analysis applied to Cancer Diagnosis

IN 1937 Dr. R. Brdička followed up an earlier (1933) observation that the sulphydryl group in proteins causes a distinct catalytic effect on polarographic current-voltage curves, by applying it to diagnose cancer through the effect the disease has upon the proteins in the blood. The results were presented to the Czech Academy of Sciences (37, 17; 1937); but publication was delayed and it is only recently that the account has reached Great Britain. It was found that carcinomatic sera give definitely smaller polarographic effects than normal sera. The method consisted in taking 0·3 c.c. of centrifuged blood serum and adding 0·15 c.c. of normal potassium hydroxide solution and 0·3 c.c. of potassium iodoacetate (which reacts with the sulphydryl group in proteins). After standing an hour, amounts of 0·1 c.c. of the mixture are taken out at intervals and added to 5 c.c. of a cobalt chloride solution containing 8×10^{-4} molar cobalt chloride, 0·1 normal ammonium chloride and 0·1 normal ammonia. The polarographic curves of these solutions are recorded, using a dropping mercury cathode, the anode being the mercury layer below the solution. In this way 67 cases were examined; 32 gave the abnormally low (carcinomatic) protein effect, in agreement with the clinical conclusions.

Quality Control for Engineers

"A FIRST Guide to Quality Control for Engineers" (London: H.M. Stationery Office, 1945. Pp. 38. 1*s.* net), compiled in 1943 by Dr. E. H. Sealy of the Ministry of Supply Advisory Service on Quality Con-

trol for use by the Ministry of Supply when there was a great demand for a scientific method of controlling the quality of mass-produced goods, has now been released for general publication in the hope of assisting in the application of statistical methods to industry. It is intended primarily for use by engineers, and all examples are taken from actual engineering work. A method of plotting the standard control chart, of establishing control limits and of interpreting the significance of their relation to the drawing limits is detailed in the first two chapters, and a method of control specially adapted to suit multi-spindle automatic machines is described in a subsequent chapter. The handbook was used during the last two years of the War by the Ministry of Supply Advisory Service on Quality Control as a simple introduction to statistical methods for engineers who wish to begin using quality control in the machine shop and who have no prior statistical knowledge.

University of London : Appointments

THE following appointments in the University of London have recently been announced : Dr. C. M. White, since 1933 reader in civil engineering at the Imperial College of Science and Technology, to the University chair of fluid mechanics and hydraulic engineering tenable at the College, as from January 1, 1946 ; Dr. Alexander Haddow, of the staff of the Chester Beatty Research Institute of the Royal Cancer Hospital, to the University chair of experimental pathology tenable at the Royal Cancer Hospital (Free), as from October 1, 1946 ; Dr. A. C. Stevenson, to the University readership in public health tenable at the London School of Hygiene and Tropical Medicine.

The following titles have been conferred : professor of environmental archæology in the University on Dr. A. F. E. Zeuner, in respect of the post now held by him at the Institute of Archæology ; reader in botany in the University on Dr. F. W. Jane, in respect of the post now held by him at University College ; reader in philosophy in the University on Dr. C. E. M. Joad, in respect of the post now held by him at Birkbeck College ; reader in pharmacology in the University on Dr. H. O. Schild, in respect of the post now held by him at University College.

Institution of Naval Architects

A research scholarship of the value of £400 a year and tenable for two years has been offered by the Aluminium Development Association to encourage and facilitate research in the application of light alloys to ship construction. The scholarship will be administered by a committee of the Institution of Naval Architects and it is hoped to make the award in September 1946. Full particulars of entry, which closes on July 31, can be obtained from the Secretary, Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1.

The Council has awarded two premiums of the Institution for the year 1945, one to Mr. A. J. Sims, for his paper "The Habitability of Naval Ships under Wartime Conditions", and the other to Mr. J. F. Allan, for his paper "The Stabilization of Ships by Activated Fins".

Library of the Zoological Station at Naples

DURING most of the war years, the Stazione Zoologica at Naples was deprived of contact with the Allied Nations. As a consequence, the files of many scientific periodicals in its world-renowned library have been interrupted. The deficiencies are being made good as speedily as possible, but there is an inevitable time-lag. Friends of the Laboratory would therefore do a service to their science and a great personal kindness to present workers at the Aquarium by sending separate prints of recent publications to the Director, Dr. Dohrn. By so doing they would help to bring the library up to date and thus assist in the rehabilitation of this international research station.

The Ray Society

AT the annual general meeting of the Ray Society, held on March 21, Dr. Malcolm Smith was elected a vice-president and Col. Seymour Sewell, Dr. E. Hindle and Mr. J. J. Jackson new members of council. It was announced that Dr. Dawes' volume on "The Trematode Parasites of British Fishes" was in the press and would form the issue to subscribers for the year 1944. Other volumes are in preparation, but no dates can yet be announced for their publication.

Announcements

THE Association of Engineers of Liège has recently awarded its Trasenster Medal to Sir Edward Appleton, secretary of the Department of Scientific and Industrial Research. The Trasenster Medal was founded by the Association in honour of M. Gustave Trasenster, an eminent Belgian metallurgist and industrialist, and is awarded each year by the Association to a distinguished learned foreigner.

THE Council of the Iron and Steel Institute has awarded the Bessemer Gold Medal for 1946 to Mr. J. S. Hollings, of Messrs. Guest Keen Baldwins Iron and Steel Co., Ltd., Port Talbot, Glamorgan, in recognition of his distinguished services in encouraging technical improvement in the manufacture of iron and steel.

THE Third Annual Mercer Lecture of the Society of Dyers and Colourists will be given at the Bell Hotel, Humberstone Gate, Leicester, on April 17, at 6.30 p.m., when Mr. Donald Entwistle, of Courtaulds, Ltd., will speak on "Synthetic Fibres from Natural Polymers".

THE first annual Fison Lecture, made available to the Veterinary Educational Trust by Messrs. Fisons, Ltd., will be delivered by Earl De La Warr at the London School of Hygiene and Tropical Medicine on May 9. He will speak on "The Work of the Agricultural Research Council and its Relation to Veterinary Science and Practice".

THE Council of the Institution of the Rubber Industry has established an annual lecture to be given on a topic of special interest to the industry, the first of which is to be given in Birmingham on May 10 by Mr. A. Healey, who will speak on "The Future of the Rubber Manufacturing Industry". Tickets for the lecture, and for the dinner which follows (price 10*s.* 6*d.*), can be obtained from Miss C. Carden, General Secretary, I.R.I., 12 Whitehall, London, S.W.1.

THE following appointments and promotions in the Colonial Office have recently been announced : R. G. Donald, to be entomologist, Gold Coast ; R. B. Allnutt (agricultural officer, Tanganyika), to be senior agricultural officer, Tanganyika ; J. T. H. Stein, J. M. Ward and J. Wright (agricultural officers, Gold Coast), to be senior agricultural officers, Gold Coast ; P. C. Lancaster (assistant conservator of forests, Nigeria), to be senior assistant conservator of forests, Nigeria.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Cosmic Rays and the Great Sunspot Group of January 29–February 12, 1946

LARGE variations in the intensity of cosmic rays have been observed during the period of the recent great sunspot group, January 29–February 12, 1946. According to information kindly given by the Royal Observatory, a magnetic storm, a considerable number of solar flares, and radio fade-outs were also observed during this period. The intensity of cosmic rays has been recorded in London and Manchester; the apparatus used in London has been previously described by one of us[1], and that used in Manchester was similar in principle, although differing in some details. The most important difference was the use of two instead of three trays of Geiger–Müller counters, which meant that rather more particles approaching from an inclined direction were recorded.

The accompanying figure shows the percentage variation in the number of cosmic rays for intervals of two hours, commencing with the period 00·30–02·30 on January 31, and finishing with the period 22·30–24·30 on February 11. For clarity the points relating to Manchester have been displaced 4 per cent upwards. One of us[2] has shown that the intensity of cosmic rays, C, is related to the barometric pressure, B, and the height, L, of the layer at which the atmospheric pressure is 7·5 cm. of mercury by the formula

$$C - C_m = \mu(B - B_m) + \mu'(L - L_m),$$

where $\mu = -2{\cdot}28$ per cent per cm. of mercury, $\mu' = -5{\cdot}4$ per cent per km., and the suffix m refers to mean values. The intensities shown on the figure have been corrected for atmospheric absorption, which is represented by the first term in the above equation, but not for the second term, which is due to the decay of mesons. The mean daily height, L, over London has been kindly supplied by the Meteorological Office and is indicated by the line and filled circles at the top of the figure; corresponding values for Liverpool are shown by open circles. The broken line at the bottom of the diagram represents the mean daily value of the horizontal force H in γ as recorded by the Geomagnetic Station at Abinger. (The values shown on the graph should be added to 18,500 γ.)

Allowing for meteorological influences, a small decrease of cosmic ray intensity appears to have occurred on February 3, the intensity remaining at this slightly lower level until a much greater decrease took place on February 5 and 6. During these days there was only a short period of minor geomagnetic activity beginning suddenly at 13·00 on February 3 and ending about midnight the same day. The major sunspot crossed the central meridian early on February 6. The terrestrial field remained more or less undisturbed until a magnetic storm commenced at 07.30 on February 7, as indicated by the broken vertical line. The development of this storm appeared to be delayed until there was a sudden large decrease in the horizontal force at 10.20, about which time there was a small but sharp peak in the cosmic ray intensity. From this time until 12.00 on February 8 there were many violent fluctuations in the horizontal force (the extreme range being 525 γ) coinciding with a further large drop in cosmic-ray intensity. After a comparatively rapid recovery of this intensity to the pre-storm value, the return to the normal value prevailing at the time of the appearance of the sunspot group has been very slow, and a month later was not yet complete. During this month there were several further small fluctuations, but the results have not yet been fully analysed. The magnitude of the total change, allowing for variations in the pressure-level (7·5 cm. mercury), can be taken as 10·5 ± 0·4 per cent in London. The decrease in Manchester appears to be rather less, but it is difficult to say whether this difference is significant, as only one balloon sent up from Liverpool reached the necessary height on February 8, and consequently the correction cannot be made accurately. In general, the cosmic ray intensities at the two stations follow one another very closely.

It may be of interest to note that this decrease, the greatest since that of March 1, 1942[2,3], has been accompanied by the recurrence of radio noise from sunspots discovered by Appleton and Hey. The decrease in cosmic ray intensity on that occasion was slightly greater than on this. The area of the sunspot in 1942 was less than half that of the one this year.

The fact that no appreciable decrease in the horizontal force was observed on February 5 and 6, whereas the decrease in cosmic ray intensity on these days was comparable to that which occurred during the magnetic storm, is very remarkable. Such a phenomenon has, however, been observed previously by one of us, and may be regarded as a counterpart of the fact that some magnetic storms are not accompanied by appreciable disturbance in cosmic rays. Thus once more it would appear that the relation between the geomagnetic field and cosmic rays must be complex, or that other influences must affect the cosmic ray intensity.

A. DUPERIER.

Imperial College of Science and Technology, London, S.W.7.

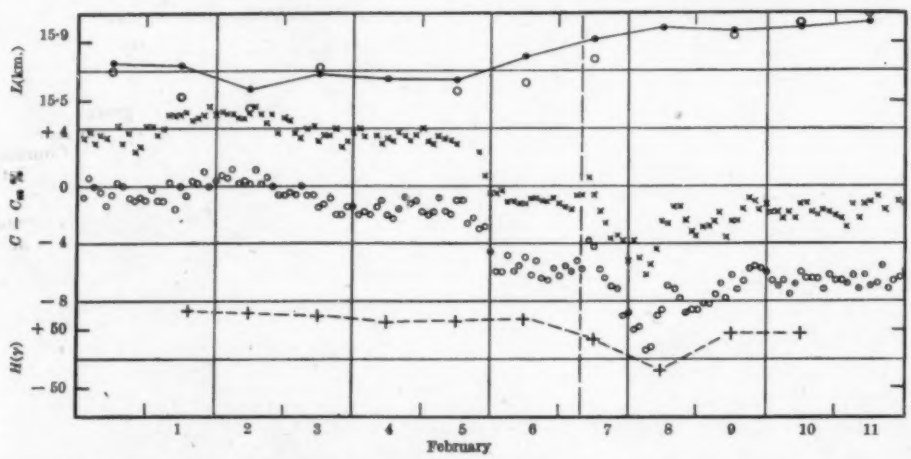
M. MCCAIG.

University of Manchester.

[1] Duperier, *Terr. Mag. and Atmos. Elect.*, **49**, 1 (1944).
[2] Duperier, *Proc. Phys. Soc.*, **57**, 472 (1945).
[3] Duperier, *Nature*, **149**, 579 (1942).

Ionosphere Storm Effects in the *E* Layer

DURING the course of an ionosphere storm, and more particularly near its beginning, I have frequently observed that the signals from short-wave stations which are situated within the skip-zone are subject to a form of distortion which is peculiar to them alone. This is quite different from the 'flutter' and other types of fading to which signals from more distant stations often become subject during an ionosphere storm, and it takes the form of a partially rhythmic note of low audio-frequency, producing the effect of a distinct and pronounced 'rumble' upon the received signal. The intensity of the 'rumble' varies directly with the wave-length of the received station, and also, apparently, directly with its power and the directivity of its aerial system. It is particularly noticeable in Britain upon the signals from the B.B.C.'s high-powered short-wave stations. I have observed this effect to begin very early in an ionosphere storm, the signals from stations within the skip-zone often being affected in this way *before* those from more distant stations begin to show any signs of deterioration due to the storm.



Mr. T. L. Eckersley has investigated the mechanism of the reception of signals from stations within the skip-zone[1,2], and his original findings have since been confirmed[3]. These are, briefly, that reception of signals from a transmitter working on a frequency above the critical frequency can be of a permanent character, and is provided by energy 'scattered' from within or just above the E layer of the ionosphere, the most important type of scattered signal being received as follows. The wave on leaving the transmitter follows an obliquely upward path, passes through the E layer and, after reflexion at the F layer, again reaches the E on its downward path where 'scattering' takes place; and part of the scattered energy coming back along the original path, it may be received at locations near the transmitter. The scattering agent is the irregular ionic clouds which always exist in the E layer—or just above it—but which do not exist in the F layer.

The object of the present communication is to suggest that the 'rumble' mentioned above—characteristic as it is of reception under disturbed conditions from stations within the skip-zone only—is due to the effect of an ionosphere storm upon the ionic clouds in the E layer and not to its effect upon the F layer. The fact that it increases in

intensity with wave-length, with power and with aerial directivity all seem to confirm this, for these are the factors which determine the intensity of a received scatter signal itself.

It is generally assumed that ionosphere storms of the kind mentioned are caused by corpuscles ejected from the sun, the effect of which, while it is pronounced in the case of the *F* layer, is small or even negligible at the height of the *E* layer. If the 'rumble' is indeed produced in the way suggested, it would seem that the corpuscles do produce a marked effect upon the *E* layer, at least upon the ionic clouds, if not upon the regular structure of the ionization. As to the exact form this effect may take, it would be rash to attempt an explanation, but it is suggested that the clouds are affected in such a way that a kind of Doppler effect is imparted to the scattered energy. A further point is that the above postulation as to the cause of the 'rumble' would provide additional confirmation of the evidence of Eckersley, Millington and Cox that the scatter is indeed from a point in the atmosphere and not from a distant point on the ground.

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Feb. 18.

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Shape of Collision-Broadened Spectral Lines

Van Vleck and Weisskopf[1], in an interesting paper, have shown that the well-known Lorentz formula for the shape of a spectral line is incorrect except at frequencies close to the resonance frequency. Since this formula has been considered to be correct for a great number of years, it may be of interest to record that, using a different method, I had reached the same conclusions[2] as Van Vleck and Weisskopf. This method, although originally developed for the case of a rigid dipole oscillating about an equilibrium position, can easily be adapted to harmonic oscillators.

Consider an assembly of N equal harmonic oscillators of which the proper frequency, mass, charge and displacement are denoted by $\omega_0/2\pi$, M, e, x, respectively. In an external field F, x satisfies

$$\ddot{x} = -\omega_0^2 x + eF/M, \quad . \quad . \quad . \quad . \quad (1)$$

whereas the energy is given by

$$E = E_0 - eFx, \text{ where } E_0 = \frac{M}{2}\dot{x}^2 + \frac{M}{2}\omega_0^2 x^2 \quad . \quad (2)$$

In a constant field $F = F_0$, the distribution function $f(x,\dot{x})$ (that is, number of oscillators per unit range of x and $\dot{x}$) is proportional to $\exp.-E_0/kT$. For sufficiently weak fields, $f = f_0 + f_1$, where

$$f_0 = C\exp.(-E_0/kT), \quad . \quad . \quad . \quad \iint_{-\infty}^{\infty} f_0 dx d\dot{x} = N.$$

and

$$f_1 = C\exp.(-E_0/kT)\frac{eF_0 x}{kT} = -\frac{eF_0}{M\omega_0^2}\frac{\partial f_0}{\partial x}. \quad |f_1| \ll f_0. \quad (3)$$

The polarization is thus given by

$$P_0 = e\int x f dx d\dot{x} = e\int x f_1 dx d\dot{x} = -\frac{e^2F_0}{M\omega_0^2}\int x\frac{\partial f_0}{\partial x}dx d\dot{x} = \frac{e^2NF_0}{M\omega_0^2} \quad . \quad . \quad (4)$$

Consider now a periodic field $F = F_0 \exp. i\omega t$. If instantaneous equilibrium could be reached, the distribution function would be

$$f_{\text{equ.}} = f_0 + f_1 \exp. i\omega t. \quad . \quad . \quad . \quad (5)$$

Assume the actual distribution function to be

$$f = f_0 + f_2 \exp. i\omega t, \quad . \quad . \quad . \quad |f_2| \ll f_0 \quad . \quad (6)$$

At any instant of time the oscillators will then tend to reach $f_{\text{equ.}}$ if they are in interaction (collisions) with a medium which is in thermal equilibrium. The main assumption of the present calculation is to suppose that the rate of change of f due to these collisions is given by $-(f - f_{\text{equ.}})/\tau$, where the time of relaxation τ may depend on temperature but is independent of x and $\dot{x}$. Adding the rate of change due to oscillation, we find

$$\frac{\partial f}{\partial t} = \frac{\partial f}{\partial x}\dot{x} + \frac{\partial f}{\partial \dot{x}}\ddot{x} - \frac{1}{\tau}(f - f_{\text{equ.}}); \quad . \quad (7)$$

or making use of (1), (5) and (6)

$$\frac{\partial f}{\partial t} = \frac{\partial f}{\partial x}\dot{x} - \omega_0^2\frac{\partial f}{\partial \dot{x}}x + \frac{eF_0}{M}\frac{\partial f}{\partial \dot{x}}\exp. i\omega t - \frac{1}{\tau}(f_2 - f_1)\exp. i\omega t. \quad . \quad . \quad . \quad . \quad (8)$$

Now insert (6) and (3) in (8), neglect terms in $F_0 f_1$ which are small of the second order, and notice that $\partial f_0/\partial t = 0$. Then

$$\left(i\omega + \frac{1}{\tau}\right)f_2 = \frac{\partial f_2}{\partial x}x - \frac{\partial f_2}{\partial \dot{x}}\omega_0^2 x + \frac{eF_0}{M}\frac{\partial f_0}{\partial \dot{x}} - \frac{eF_0}{\tau M\omega_0^2}\frac{\partial f_0}{\partial x}. \quad . \quad . \quad . \quad (9)$$

This equation can be solved by putting

$$f_2 = a\frac{\partial f_0}{\partial x} + b\frac{\partial f_0}{\partial \dot{x}}, \quad . \quad . \quad . \quad (10)$$

where

$$a = -\frac{eF_0}{M\omega_0^2}\frac{1}{2}\left\{\frac{1 + i\omega_0\tau}{1 + i(\omega + \omega_0)\tau} + \frac{1 - i\omega_0\tau}{1 + i(\omega - \omega_0)\tau}\right\},$$
$$b = \frac{\tau}{1 + i\omega\tau}\left(a\omega_0^2 + \frac{eF_0}{M}\right). \quad . \quad . \quad (11)$$

The total polarization P is thus given by (if we note that $\int x\frac{\partial f_0}{\partial \dot{x}} = 0$, and make use of (11) and (4))

$$P = e\int x f dx d\dot{x} = e\int x f_2 \exp.(i\omega t) dx d\dot{x} = ea\exp. i\omega t \int x\frac{\partial f_0}{\partial x}dx d\dot{x} = \frac{1}{2}\left\{\frac{1 + i\omega_0\tau}{1 + i(\omega + \omega_0)\tau} + \frac{1 - i\omega_0\tau}{1 + i(\omega - \omega_0)\tau}\right\} P_0 \exp. i\omega t, \quad . \quad . \quad . \quad (12)$$

in agreement with Van Vleck and Weisskopf's equations (17) (18), which are obtained as the real and imaginary parts (the latter multiplied by ω) of P/F.

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Jan. 10.

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'Impregnation' of Defect Lattices in Iron Oxide Scales

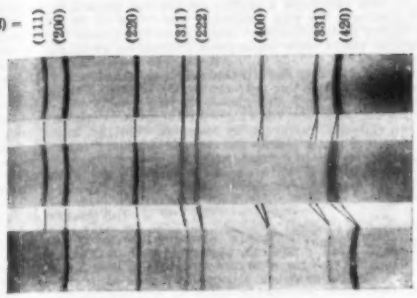
In the course of an X-ray examination on scales formed on steels, a structure phenomenon was observed which is believed to be of general interest. Magnesia is known to possess a considerably smaller lattice-parameter than ferrous oxide, with which it is isomorphous. If, therefore, wüstite (the FeO solid solution) dissolves magnesium oxide, its parameter would be expected to decrease, as the smaller Mg++ ion replaces Fe++. To test this, a FeO–MgO solid solution was allowed to form, by coating Armco iron with pure magnesia, and oxidizing in air at 1,000° C.; the scale was then examined by powder-photographs. The result was that the ferrous oxide had split into two phases, both of the same structure (rocksalt type), and, surprisingly, not of a decreased but an *increased* lattice parameter, compared with the oxide formed on non-coated iron under otherwise identical conditions. The accompanying photographs illustrate the effect. The measured dimensions were as follows:

Ferrous oxide phase formed on:	Lattice parameter (A.)
Uncoated iron	4·284
MgO-coated iron	(a) 4·298 (b) 4·317
Pure MgO	4·230

The reason for this expansion is that the magnesium ions, instead of replacing ferrous ions in the wüstite lattice, occupy vacant lattice-positions, until all 'holes' are filled. Thenceforward a normal contraction takes place. The theoretical saturation parameter, derived by extrapolating the known pure wüstite values to the equiatomic composition (FeO), and allowing for the difference in the ionic radii of Fe++ and Mg++, is 4·328 A., assuming all vacant sites in single-phase wüstite to be occupied. This would mean an expansion of the cube edge of 4·328–4·284 = 0·044 A., compared with uncoated iron. The actual expansion, being divided between two phases of practically equal amounts, is $\frac{1}{2}|(4{\cdot}298 - 4{\cdot}284) + (4{\cdot}317 - 4{\cdot}284)| = 0{\cdot}023$ A., that is, in the present case occupation has proceeded to approximately half the saturation value.

Thus it can be said that the defect lattice of wüstite has been 'impregnated' by magnesium ions. Since vacant metallic lattice sites are liable to aid outward diffusion of anions (FeO in scales affords poor protection against further oxidation), the question arises whether by such impregnation the corrosion resistance can be improved. According to Wagner[1], the deficiency of metal ions in oxide structures (for example, Cu_2O,FeO) increases the electrical conductivity and also explains the greater oxidizability of iron compared with other metals (compare, for example, Pfeil's work[2]). This is reflected by the considerable decrease in Fe : O ratio of the ferrous oxide phase, below the value of the stoichiometrical composition, from the iron/scale to the scale/oxygen interface, reported, for example, by the writer[3].

Quantitative hot oxidation tests in pure iron, with and without magnesium oxide covering, carried out to detect any protective effect due to the impregnation, have so far shown no improvement of cor-



a. Ferrous oxide formed on pure iron.
b. " " " iron covered with magnesium oxide.
c. Magnesium oxide.

rosion values; this may not, however, be conclusive, because macroscopic factors, such as porosity and intergranular cracking of the oxide layers, may well mask the more subtle lattice effect. In these tests the complete embodiment of magnesia in the wüstite structure was also manifest from the physical appearance of the scale (colour, layering, adherence, etc.), which was indistinguishable, whether magnesium oxide had been present or not.

The purpose of the present note is chiefly to report the existence of 'impregnated' ferrous oxide; its physical properties have not as yet been fully studied. It may not, however, be irrelevant to consider the phenomena from the point of view of catalysis, in that catalytic action is known to depend in many cases on the adsorption of foreign atoms in the crystal lattice, and defect structures such as FeO greatly facilitate such adsorption, provided ionic size and valency are favourable.

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X-Ray Examination of Hail

DURING a hailstorm on February 1, 1946, we collected a number of stones, each approximately 9 mm. across, and having the familiar concentric formation of hard hail. These were kept in a domestic refrigerator, and sections, 1–2 mm. thick, of three of them were photographed in a circular camera at about − 5° C., using a 1 mm. diameter cylindrical beam of copper $K\alpha$ radiation. The photographs were those of single or (in one case) several single crystals of tridymite ice—the normal form. Neighbouring portions of one hailstone showed no observable difference in orientation. Unfortunately, an accidental interruption of the refrigeration allowed the stones to melt before we were able to examine any one of them thoroughly, to see whether there was a relationship between the crystal orientations in successive concentric layers.

Good single crystals of ice can be grown in cold weather within an hour or two, but an abrupt cooling of water, say, by a freezing mixture or by liquid air, usually results in the formation of a coarse powder. Our experiments show, therefore, that the hailstones were probably formed by a relatively slow fall of temperature in the air through which they passed.

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Supporting Electrolytes in Polarographic Analysis

BUFFER solutions containing ammonia and an ammonium salt have been widely used as supporting electrolytes in polarographic analysis. Tyler and Dean[1] found that the total ionic concentration of such a solution might be increased without greatly affecting the reduction steps of copper and zinc, so that slight variations of concentration were less important than in other supporting electrolytes. Lingane[2] reported that the diffusion current constants of copper, cadmium and zinc in ammoniacal solutions were higher than those found in decinormal potassium chloride. From his data, it may be calculated that the mobilities of the complex ammino-cations in ammoniacal solution are considerably greater than those of the aquo-ions, and correspond to an apparent ionic radius less than 3 A.

Wille[3] has measured the transport numbers of cupric ions in water and in the presence of excess ammonia. Although in his series of solutions the position of equilibrium is not constant, it is apparent that the transport number at infinite dilution of the complex cuprammonium cation is much less than that for the aquo-ion, and, assuming Stokes's law to hold for the large complex cations in aqueous solutions, corresponds to an ionic radius of about 5 A. From data on the relevant bond-lengths, the radius of the cuprammonium cation would be expected to be of the order 3·5 A. Hence the complex ion, despite the low charge-density at its surface, is probably able to attract water molecules in aqueous solution; but in strong ammoniacal solutions, there will be less solvation.

It is possible that the peculiar structure of ammoniacal solutions may be of importance in allowing ready diffusion of complex cations. Fajans and Johnson[4] have discussed the evidence that the ammonium ion fits into the tetrahedral structure of liquid water, and possibly stabilizes it. With other complex-forming molecules such as pyridine or tetramethyl ammonium hydroxide in ammonium salt solutions, the polarographic properties are inferior to those of ammonia – ammonium chloride solutions, especially at the highest concentrations. This is presumably due to the fact that excess of the complex-forming agent must be added to ensure full co-ordination, and the large molecules distort the solvent structure.

Experimental results suggest that the anion in the supporting electrolyte affects much less the polarographic properties; chloride, iodide and sulphate anions, with similar mobilities, give suitable buffers for polarographic analysis, and even the larger acetate, perchlorate, and carbonate ions do not reduce diffusion currents greatly.

Considerable amounts of monovalent and divalent cations may be present in ammoniacal solutions without altering the desirable polarographic features. In a solution molar with respect to ammonia and ammonium chloride, as much as one half of the total ammonium ion may be replaced by potassium, without affecting greatly the reduction steps on the curve. However, if the *p*H of the solution is to be kept constant, it is necessary to reduce the concentration of ammonia equally with that of the ammonium salt. At *p*H values above 10, divalent metals may be precipitated.

In one respect the supporting electrolytes may even be improved by addition of cations. In polarograms with ammoniacal supporting electrolytes, there is a steep rise of current at about − 1·7 V. with respect to the saturated calomel electrode, because the ammonium ion catalyses the deposition of hydrogen and reduces its over-potential. In a molar solution of lithium chloride, the over-potential is about − 1·95 V. If some of the ammonium salt in an ammoniacal buffer is replaced by lithium chloride, an intermediate over-potential value is obtained, and a larger portion of the current-voltage curve is therefore available for analytical purposes. In particular, the diffusion current of the manganese wave, often obscure in ammoniacal buffers, is much clearer in lithium-ammonium mixtures. The diffusion current constants are scarcely affected by this incorporation of lithium into the buffer.

When trace elements in plant material are being estimated polarographically, the cations may be separated from interfering anions by means of synthetic resin adsorbers. The eluted cations may then be estimated in a single polarogram, using an ammoniacal supporting electrolyte. It is not necessary to isolate the trace elements from other cations (calcium, potassium, magnesium) invariably present in plant digests, provided that their total concentration does not exceed that of ammonium ion in the test solution.

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Polarographic Investigations in an Ethylene Glycol Medium

DESPITE the many contributions that have been made to the literature of polarography, very few papers have dealt with electrolysis employing a dropping mercury electrode in non-aqueous solvents[1]. Nevertheless, such work is of theoretical interest and may well attain some practical importance in analytical and physical chemistry.

The present studies have been concerned with solutions in carefully purified, anhydrous ethylene glycol. The solutions have all contained 0·5 gm. of potassium chloride in 100 ml., and have been protected from atmospheric moisture. It has been found necessary to gas the solutions with dry, oxygen-free hydrogen for two hours, in order to remove the oxygen, which would otherwise give a double wave similar to that obtained in aqueous solutions. Throughout this work, a pool of mercury has been used as the non-polarizable anode, owing to the difficulty of correcting for the liquid junction potential if a standard half-cell were used. The iR drop[2] in ethylene glycol solution has been measured and found to be negligible in comparison with the applied E.M.F.

Polarograms of very dilute solutions of a number of anhydrous salts in the supporting medium have been recorded, and the half-wave potentials *v.* the mercury anode, of cadmium, zinc, thallous, cuprous, cupric and ferrous ions measured. A comparison of these half-wave potentials with those obtained under identical conditions in aqueous solution has shown that the value for a given ion agrees to within ± 0·02 volt. The current-voltage curves in ethylene glycol have all been well defined, and except in the case of cuprous copper, which exhibited a small maximum, no irregularities have been observed.

Quantitative experiments with thallous ion have established that, in accordance with Ilkovic's equation[3], the diffusion current is directly proportional to the concentration of the reducible ion, to within the experimental error of ± 2 per cent. The diffusion current of a given concentration of thallous ion in ethylene glycol solution is smaller than the diffusion current in aqueous solution, in the ratio of 1 to 4·3.

A series of experiments have been made on solutions containing a fixed concentration of thallous ion in the presence of the large excess of potassium chloride in solvent mixtures ranging from anhydrous ethylene glycol to water. It has been established that the product of the diffusion current and the square root of the viscosity of the medium is a constant to within an experimental error of ± 1 per cent, and is independent of the composition of the solvent.

The results of the present investigations have shown that the general theoretical basis of polarography is applicable to ethylene glycol solutions, and that current-voltage curves obtained with the dropping mercury cathode in this medium exhibit no peculiar features.

I wish to thank Mr. J. A. M. van Moll and the directors of Philips Lamps, Ltd., for permission to publish this work.

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Incomplete Breakdown : a Cathode De-ionization Effect

Considerable interest has been taken in the phenomenon of 'stepped' breakdown in the electric spark, and experimental investigations have been made, notably by Tamm[1] and others[2], using oscillographic records of the collapse of voltage across the gap. Studies have also been made by Raether[3] of the growth of the space charges in the gap, using the cloud-chamber method. These experiments were mainly concerned with short gaps of the parallel-plate type in air at reduced densities. In many practical applications of short spark gaps, however, high gas densities are required, and if similar effects are found to occur at these high gas densities, any 'stepping' of the voltage across the gap during the initial phase of the breakdown can have serious consequences in that complete breakdown of the gas insulation is prevented. The gap can thus develop an appreciable resistance in which considerable power may be dissipated. The occurrence of this effect would render the spark gap useless in those circuits which require sudden surges of high peak-current through a low-resistance path.

During a study of the properties of short gaps of the parallel plate type, I have investigated this effect at atmospheric pressures using tungsten disks as electrodes set about 0·2–0·5 mm. apart. The voltage across the gap was measured by means of a cathode ray oscillograph, but the resistance of the spark path was calculated indirectly. For this purpose the spark was made to excite oscillations in a tuned high-frequency oscillatory circuit to which was coupled another tuned circuit. Estimates of the resistance of the spark path during the initial collapse could then be made from measurements of the magnitude of the high-frequency potentials developed across the coupled circuit when the constants of the oscillatory circuits are known.

A typical oscillogram showing incomplete breakdown is given in Fig. 1, which shows two practically identical successive traces superposed. It is seen that the sparking potential fell from its initial value of 2·5 kV. to about half that value, and then recovered to follow the shape of the applied pulse of E.M.F. after the spark was extinguished due to excessive de-ionization. The estimates made of the gap resistance showed that this did not fall to the expected low value for this length of gap.

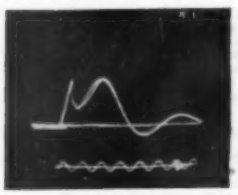

Fig. 1.

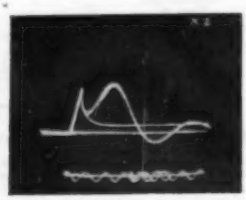

Fig. 2.

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In the preliminary experiments this effect was noticed only with clean electrode surfaces. However, it was found that if the electrodes were allowed to stand in air for some time after considerable sparking had taken place in the gap, then the resistance for subsequent sparks was low, and the oscillographic records showed that the voltage fall was not halted as before. Experiments were then made in which the electrodes were covered with a fine dust of various oxides, such as alumina or magnesium oxide, and it was found that complete breakdown could then be obtained. By examining the effects on each electrode separately, it was found that the state of the cathode surface rather than that of the anode was the controlling factor. Further, the particular state of the cathode surface which ensured complete collapse also tended to reduce the statistical time-lag of the gap on impulse breakdown. It is known that the presence of oxides like alumina can reduce the statistical lag of short gaps[4,5,6] by producing cathode emission, and the present experiments show that tungsten oxide can have a similar effect'.

From these and other results, it was concluded that electron emission at or very near the cathode during the actual breakdown process of the spark discharge, and not, as is usually considered, during the pre-breakdown stages only, is necessary for the complete collapse of the discharge path resistance. Owing to the high current-density involved, and also owing to the low rise in temperature of the whole electrode even with recurrent discharges of about 300 per second, the mechanism of electron production at the cathode is probably that of auto-electronic emission.

When the cathode was clean and smooth, the electric field-strength at the surface just before breakdown in the gaps considered above was of the order of 10^8 V./cm., so that under those conditions auto-electronic emission was negligible, since the microscopic field was probably not very different from the macroscopic field. However, when with such electrodes a thermionic arc was allowed to follow the initial breakdown, the gap resistance was found to be low. Fig. 2, though slightly distorted, shows three traces superposed : two practically identical traces show incomplete breakdown as in Fig. 1, while the other shows the voltage fall right down to the arcing value (shown as a straight line). This showed that electron emission from the cathode, whether thermionic or auto-electronic, occurring throughout the breakdown process and not merely at the onset, maintained the spark until complete breakdown resulted : for that reason such post-breakdown emission was probably essential. Further, any cutting off of this source of ionisation at the cathode surface during breakdown then impedes the rise of current, and may even extinguish the spark.

This conclusion may have application to the electrodes of mechanical contact-making devices as well as to spark gaps used in electrical engineering.

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Particle Counts in the Ultramicroscope

When using the type of ultramicroscope designed by Prof. Whytlaw-Gray[1] for the counting of particles in smoke and other aerosols, a stream of gas is passed intermittently through a glass cell of known dimensions, which is strongly illuminated. The number of particles which scatter light is noted each time the gas stream stops. The distribution of particle counts was found to follow a Poisson series very closely. Thus the number of times one would expect to find 0, 1, 2, 3 . . . n particles in the field is given by

$$N\left(1, \bar{x}, \frac{\bar{x}}{2!}, \frac{\bar{x}}{3!} \cdots \frac{\bar{x}^n}{n!}\right)$$

where N is the total number of fields counted and $\bar{x}$ is the average number of particles per field[2].

For example, when counting gum particles in coal gas, 143 fields were counted with an average number of particles per field of 1·44. The distribution found and calculated was as follows :

No. of particles in field	Number of times occurring Found	Calculated
0	34	34
1	46	49
2	38	35
3	19	17
4	4	6
5	2	2
6	0	0·4
	143	143·4

This observation may prove useful in checking particle counts. For example, on another occasion the agreement was not so good, the following results being obtained :

No. of particles in field	Number of times occurring Found	Calculated
0	81	78
1	121	136
2	121	119
3	93	68
4	17	30
5	6	11
6	6	3

Here it seems that several fields which really contained four particles have been noted as containing only three. Such a result may be due to faulty adjustment of the lighting, fatigue, etc., and a new count should be made.

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Anomalous Behaviour of Fused Cryolite

Natural cryolite (Na_3AlF_6), when fused in a platinum crucible, yields a typical 'wetting' melt, which gradually spreads over the interior of the crucible and may even creep over the edge. When minute amounts of lead, bismuth or thallium compounds are added, a remarkable and practically instantaneous change is observed in the nature of the melt, which becomes 'non-wetting' and forms a single large drop with sharply defined boundaries.

The effect is confined to compounds of the three metals mentioned (atomic numbers 81, 82, 83), although carbon produces a superficially similar effect due to the formation of a layer of carbon monoxide between the melt and the platinum surface. The phenomenon persists

for only 20–30 sec. with thallium, owing to the high volatility of its fluorides. In no instance has admixture with up to 5 per cent of other compounds been found to interfere with the effects of lead and bismuth. No permanent modification of the surface of the platinum can be postulated, since no anomalous behaviour is observed when pure cryolite is fused in a platinum crucible from which a non-wetting melt has been cleanly detached.

Although the precise limits have not been determined, it is known that as little as 1 part of lead or bismuth in 5,000 can cause this non-wetting effect with cryolite. The limits are higher for potassium cryolite (K_3AlF_6), being approximately 1 part in 20 for lead and 1 in 400 for bismuth.

Synthetic cryolite, prepared from hydrofluoric acid and tri-sodium aluminate solutions in lead vessels, is non-wetting; but, when made in rubber or platinum ware, the synthetic material cannot be distinguished in behaviour from natural cryolite.

Other melts, such as sodium sulphate, sodium fluoride, sodium tungstate and potassium sulphate, are affected like cryolite, while sodium chloride and metaphosphate are not. Lead fluoride itself forms a 'wetting' melt in platinum and does not become 'non-wetting' until nearly twice its weight of cryolite has been added.

Although no explanation of these phenomena is proffered at the present juncture, it is felt that the unusual nature of the observations makes it desirable to place them on record.

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Sept. 25.

Approximate Expression for Loss of Heat from Exposed Surfaces

THE standard expression for the loss of heat from exposed surfaces by radiation and convection is:

$$H = 1{\cdot}36E \times 10^{-12}(T_1^4 - T_2^4) + 5{\cdot}0 \times 10^{-5}(T_1 - T_2)^{5/4},$$

where H is loss in cal./cm.²/sec.; E is emissivity ($E = 1{\cdot}0$ for black body); and T_1, T_2 are absolute temperatures of surface and surroundings.

This expression is clumsy to solve and is usually employed in the form of diagrams or tables. It can be closely approximated for practical purposes up to 350–400° C. above room temperature for any emissivity by an expression:

$$H = A\theta + B\theta^2,$$

where θ is excess of body temperature above surroundings.

Values for A and B have been found for various assumed values of E using $\theta = 100$ and $\theta = 300°$ C., that is, $T_1 = 385$ and 585, and $T_2 = 285$.

The values are:

E	A	B
1·00	$1{\cdot}96 \times 10^{-4}$	$1{\cdot}71 \times 10^{-6}$
0·75	1·80	1·34
0·50	1·64	0·98
0·25	1·48	0·62
0	1·33	0·25

It so happens that these values of A and B are linear with respect to E, so that generally:

$$H = 10^{-4}(1{\cdot}33 + 0{\cdot}63E)\theta + 10^{-6}(0{\cdot}25 + 1{\cdot}46E)\theta^2$$

is a close approximation over the prescribed range.

The use of this expression enables problems of various types to be solved as a simple quadratic equation. For example, the calculation of the heat loss through a body exposed to a known temperature on one side and cooled by natural convection and radiation on the other comes into this category, and it is also simple to find the temperature reached by a body exposed to a steady stream of radiation. The expression leads to estimates of the temperatures in these cases which are more than sufficiently accurate for practical purposes.

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'Industrial' Separation of Isotopes

IT has been shown[1], and confirmed by other workers[2], that carbon tetrachloride evaporated in the vicinity of a charged Van de Graaff electrostatic generator almost doubled the voltage of the spherical electrode. The phenomenon was attributed to the difference of mobility of the molecules of carbon tetrachloride and that of the average air molecule, and the electro-affinity of the former.

The effect is most striking on sharp edges and points on the electrodes. The corona effect appearing on them is instantly suppressed in the presence of carbon tetrachloride vapour.

When the surrounding gas mixture is ionized, there is a double flow of ions to and from the charged electrode. The mobility of ions is inversely proportional to the square root of their molecular weights. Thus the mobility of carbon tetrachloride ions is about one third of that of other ions present in air. A layer of increased concentration of the heavier ions is thus formed in contact with the electrode. The concentration is sufficiently high to change the behaviour of the electrode and should be considerable on the contact surface.

The increased tension of the generator is due to the sudden lowered rate of loss of charges.

It is thought that the Van de Graaff or Pauthenier high-tension generators might be used effectively to separate gas mixtures into their constituents in accordance with their molecular weights. The large surface of the electrodes in question and the considerable voltage available suggest the possibility of separation on an 'industrial' scale[3]. Certain modifications of the electrodes when used for the purpose of separation should increase the amounts of material that could be dealt with as well as the separation factor.

The method is not limited to gases only.

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Dec. 17.

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A New Anti-Vibration Support

IN his investigation of the optical constants of liquid metals, Aster[1] placed marble slabs on sand to obtain a shock-proof arrangement. This proved impracticable in my work. The laboratory is situated on the second floor of a large five-storey building. The vibrations of the latter, trolley-buses passing at no great distance, and the running of an electric motor in the laboratory made it imperative to devise a support which would eliminate the effect of all these factors on a mercury surface, and, at the same time, be rigid enough to carry a small furnace.

The application of newspaper paddings, sawdust, cycle- and car-tyres, large 'india-rubbers', books, heavy stone-slabs, sand and cork, separately or combined, was fruitless.

Finally, the cycle-tyre was cut into sections about one and a half inches long. The straight edges were gripped, turned inside out and pinned together. They provided spring elements of great elasticity. Square cork slabs (6-in. edges) were then piled on top of each other until a height of about two inches was reached. On these there were placed eight of the above rubber springs, which formed approximately a circle. Another two-inch layer of cork was laid on the springs and a retort-stand placed on the former. Two other similar supports were erected. Three eyes, screwed into three lengths of curtain-wire (18 in.), were fixed to a wooden board (12 in. × 15 in.), and this arrangement was then suspended from the retort-stands. A heavy stone-slab was carefully lowered on to the board and the basin filled with mercury was put on the slab.

Every attempt to transmit vibrations to the mercury via the floor proved to be futile.

An effort was made to eliminate the rubber springs, but it was soon found that they formed a crucial part of the supports. It is felt that the many degrees of freedom—the thickness of the cork, the length of the (expanding) curtain-wires, the weight of the stone-slab—enable the arrangement to meet a large variety of conditions. In this, as in its economic aspect, the simple set-up is superior to various factory-made products.

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Red Dwarf Stars

THE characteristics of a red dwarf star are: low luminosity (say, not more than one tenth that of the sun), small mass (say, not more than three quarters that of the sun) and high density (perhaps 30–100 times the density of the sun).

That stars of small mass should be of low luminosity is not surprising, but that the density should be as high as it is has always been somewhat of a puzzle. The purpose of the present note is to offer what appears to be an explanation of the high density.

The energy radiated by the sun and by other stars of the main sequence is believed to be due chiefly to the conversion of hydrogen into helium, the reaction taking place in the central core, which is assumed to reach a sufficient temperature to make this reaction possible.

Now when a cloud of scattered material first contracts to form a star or planet, the hydrogen which it contains tends to collect in the outer layers rather than in the core, and, in the case of the planets, this distribution of material is permanent.

In the case of stars belonging to the main sequence, it seems to be necessary to assume that the general conditions in the interior of the star are such that convection currents occur which are of sufficient importance to convey hydrogen in adequate amounts from the outer layers to the central core, although this does not imply that the convection currents are of sufficient magnitude to be the dominating factor in determining the distribution of temperature.

It would be unreasonable to assume that all stars the mass of which is appreciably less than that of the sun are deficient in hydrogen; and what suggests itself is that the red dwarfs probably contain a normal proportion of hydrogen, but that convection currents in these stars have never been of sufficient magnitude to convey the hydrogen in adequate amounts from the outer layers to the central core. Presumably there is a critical value of the mass which determines the actual course of stellar evolution. When the mass of the star is less than this critical value (say three quarters the mass of the sun), the hydrogen which the star contains never reaches the core in sufficient quantity to initiate and sustain the process of transforming hydrogen into helium, and dynamical equilibrium is secured only by contraction involving comparatively high densities.

On this theory the red dwarfs are not stars of great age which have consumed their substance in riotous living; they are simply feeble things which have never been able to make use of the supplies of fuel which they actually possess.

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Yule's 'Characteristic' and the 'Index of Diversity'

THERE have recently been two attempts to study the problem of random sampling from a mixed population in which all the constituent groups are not equally abundant.

R. A. Fisher[1] studied the problem of random samples of a population of insects in which the species were not equally abundant. Making the assumption that the frequency distribution in the population sampled might be of Eulerian form, he showed that the frequency in the sample should then be a negative binomial, or in certain simplified cases a logarithmic series n_1 ; $\frac{n_1 x}{2}$; $\frac{n_1 x^2}{3}$, etc., where n_1 is the number of groups with one unit and x is a constant (for the sample) less than unity.

He was also able to show that in this case the ratio of $\frac{n_1}{x}$ is constant for all samples from the same population and therefore it is a property of the population. We have called this the 'Index of Diversity' (α) and the theory has been found to fit in well and to be a useful weapon in many biological problems[2,3].

G. Udny Yule[4] has attacked a somewhat similar problem in a study of the frequency distribution of different nouns in random samples of nouns taken from writing by various authors. Making the general assumption that the frequency of different nouns in the population (which is the 'mind' of the author) is such that it has a mean M and a standard deviation σ, he shows that in all samples from the same population $\frac{S_2 - S_1}{S_1^2}$ should be a constant, when S_1 and S_2 are the first and second moments of the observed frequency series in the sample (that is, Σfx and Σfx^2). This is shown to be more or less correct in several samples taken from the same work.

I think it is therefore of interest to point out that in the logarithmic series suggested by Fisher,

$$S_1 = \frac{n_1}{1-x} \quad \text{and} \quad S_2 = \frac{n_1}{(1-x)^2}$$

and hence it follows that

$$\frac{S_2 - S_1}{S_1^2} = \frac{x}{(1-x)S_1} = \frac{x}{n_1} = \frac{1}{\alpha}$$

In other words, when the logarithmic series is applicable, Yule's Characteristic $\left(1{,}000 \times \frac{S_2 - S_1}{S_1^2}\right)$ is proportional to the reciprocal of our "Index of Diversity".

I have worked out the 'α' values for certain of Yule's samples of nouns, and Yule's 'characteristic' (K) for several of my light-trap samples of insects as follows :

NOUNS IN MACAULAY'S ESSAY ON BACON

Sample	No. of units	No. of groups	α	K
1	2000	903	618	27·9
2	2041	964	678	28·8
3	4004	1409	786	26·6
4	4049	1432	790	26·5
5	8045	2048	887	27·2

MACROLEPIDOPTERA IN LIGHT TRAP AT HARPENDEN

Sample	No. of units	No. of groups	α	K
1933	3541	178	39·15	287·6
1934	3275	172	38·64	252·8
1935	6828	198	38·19	882·9
1936	1977	154	39·05	416·1
4 years	15609	240	40·24	391·0

From this it will be seen that in the noun samples (which are not in logarithmic series) α is variable, but K very constant; but in the moth samples the reverse is the case.

Further investigation is much needed both on the mathematical side and in testing against biological data.

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Micro-stimulation of the Human Retina

BY correcting the chromatic difference of magnification of the lens-system of the eye, and by using very small test objects as stimuli, it has been found possible to construct a plan showing the approximate positions of some of the photo-receptors of my own left retina. Four methods have been employed and their results correlated.

(1) Retinal astigmatism using a special test object. This showed that the maximum acuity area for green light was *T*-shaped, *L*-shaped or +-shaped.

(2) The relative positions of the fixation points for red, green and blue light. They were found to form an acute-angled triangle with green at the apex, red at the left-hand end of the base, and blue at the right-hand end.

(3) The apparent colour of a tiny neutral grey disk, placed in various positions around the green fixation point.

(4) The size of the area of most acute vision.

Of the three possible shapes for the maximum acuity area for green light, the *T*-shape was found to fit in best with the other data ; see Nos. 4, 5, 6 and 8 on plan.

PROVISIONAL PLAN FOR THE PHOTO-RECEPTORS OF THE HUMAN FOVEA.

No. 1 Red	No. 2 Blue	No. 3 Red
No. 4 Green	No. 5 Green fixation	No. 6 Green
No. 7 Red fixation	No. 8 Green	No. 9 Blue fixation

Each area contains from four to nine cones. The middle green area No. 5 is the fixation point for green ; No. 7 is that for red, and No. 9 that for blue. Areas 4, 5, 6 and 8 are normally used for seeing fine detail by white light, for example, when reading small print. Since the retinal image is inverted by the lens system of the eye, the up strokes of the letters fall on area 8.

The collection of sense organs of any one kind into areas as shown on the plan is in accordance with the cluster hypothesis. Cluster formation of a similar kind is seen in the Lumière screen used for colour photography. This screen is prepared by mixing starch grains, some red, some green and some blue, together. The clusters of grains are easily seen with a low-power magnifier. They cause the screen to have a mottled appearance.

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Food and the Digestive Processes of the Lamellibranchs

IN most of the recent literature[1-3] concerning the food, feeding habits and digestive processes of the lamellibranchs, it is claimed : (1) that the food of this class (septibranchs excepted) consists of minute particles mainly of plant origin ; (2) that the digestion of protein and fat is exclusively intracellular and takes place either in the cells of the digestive diverticula or in wandering phagocytes ; (3) that the digestive diverticula are not organs of secretion.

The results of studies carried out in the Department of Zoology, Fouad I University, Cairo, and the Marine Biological Station, Ghardaqa, on *Tridacna elongata*, *T. squamosa*, *Pinctada vulgaris*, *Ostrea cucullata*, other *Ostrea* species, two species of *Mytilus* and *Unio pravisdens* are contrary to the above-mentioned claims.

Examination of the stomach contents of the marine forms soon after being caught or soon after being fed invariably showed the presence of ordinary net zooplankton, for example, copepods of about 1·5 mm. in length, larvæ of Crustacea, etc., either whole or undergoing digestion. *Tridacna*, which is claimed by Yonge[3] to subsist mainly on the zooxanthellæ it harbours and to be incapable of taking in food particles 14μ in diameter was found to be no exception[4].

Experiments with filtered phagocyte-free stomach juice of *Tridacna* and *Pinctada* proved the presence of free proteolytic and lipolytic enzymes as well as of those acting on carbohydrates[5].

The claim that the digestive diverticula are not secreting organs has been supported by the negative results of the iron-injection technique[6]. However, previously starved specimens of *Unio*, of which both digestive diverticula and fæces had become free of any colouring matter and which were kept on colourless food and injected in the foot with a chlorophyll solution, showed subsequently brown-greenish globules in the cells of the diverticula. These globules were later observed in the lumen of the gut. By and by the fæces became brown-greenish in colour. The passage of the colouring matter from the blood into the lumen of the gut through the cells of the diverticula is an indication of the secreting action of these organs.

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Tissue Changes in Experimental Mice Treated with Pentose Nucleotides

TISSUE changes in mice injected with a commercial mixture of the four pentose nucleotides of ribonucleic acid have been previously described[1]. Observations on normal and tumour-bearing mice treated with guanylic, adenylic, cytidylic and uridylic acids have now shown changes in the tissues and blood which are characteristic of the individual nucleotides.

Tumour-bearing mice. The accompanying table shows the results of administering nucleotides, and also sodium phosphate used as a solvent, by injection into pure-line (*C57, CBA*) mice grafted with homologous methylcholanthrene sarcomas. It suggests that the purine nucleotides, adenylic and guanylic acids, exert inhibitory actions on tumour-growth, whereas the pyrimidine nucleotide, cytidylic acid, has little or no effect, and that uridylic acid exercises a promoting action on tumour development.

Examination of splenic changes accompanying the growth of the sarcomas showed that the spleens of mice in Groups 1 and 4 were decreased in weight as compared with the controls, and the number of giant cells per unit area markedly lessened. Mice of Groups 3 and 5 showed increase of splenic weight compared with the controls,

Compound used	Tumour	No. of mice treated	Total wt. of tumours (gm.)	No. of controls	Total wt. of tumours (gm.)
(1) Adenylic acid	C57	51	179·6	51	291·8
(2) Guanylic acid	CBA1	23	16·8	23	42·7
(3) Guanylic acid	C57	31	132·2	31	202·0
(4) Cytidylic acid	C57	30	152·0	30	157·3
(5) Uridylic acid	C57	12	73·1	12	59·4
(6) Sodium phosphate	CBA1 C57	17	61·6	17	65·7

guanylic acid appearing to cause a considerable increase of giant cells per unit area. The number of these cells in spleens of mice treated with uridylic acid were comparable with those found in the controls. No estimation of the number of giant cells per unit area in the spleens of mice of Group 2 was made owing to the prevalence of amyloid infiltration of this organ.

Normal mice. Normal stock or pure-line mice treated with adenylic or cytidylic acid showed a considerable rise in the total white blood cell count within twenty-four hours of the initial injection. This leucocytosis was maintained with some fluctuation throughout the period of treatment. Absolute values of lymphocytes, polymorphs and immature myeloid cells were increased, with frequent crossing of the lymphocyte line by that of the polymorph. A rise in the number of eosinophils was infrequent and never exceeded 6 per cent. Amyloid infiltration of spleen and liver was noted in mice treated with adenylic acid, but not in those injected with cytidylic acid. Reticulosis and plasmacytosis of lymph nodes was usual.

Mice treated with guanylic acid showed either a slight initial rise or fall in the total white blood-cell count within twenty-four hours after the first injection. Successive doses failed to cause more than a moderate leucocytosis. Crossing of the lymphocyte line by that of the polymorph occasionally occurred, but a considerable rise in the number of eosinophils was a marked feature, often totalling 12-16 per cent (normal percentage 1 to 3). Amyloid infiltration of liver and spleen was also noted, with plasmacytosis and reticulosis of lymph nodes.

Iron-reacting material and non-iron-reacting pigment were usually found in the lymph glands and spleens of all the mice treated with the three nucleotides. Further investigation in relation to splenic weights and number of giant cells is being carried on.

The systemic effects of the growth of primary and grafted sarcomas have already been described[2]. These include a leucocytosis often of leukæmic proportions, an increase of myeloid cells with crossing of the lymphocyte and polymorph lines, reticulosis and plasmacytosis of lymph nodes, iron-reacting deposits in lymph glands, liver and spleen, and amyloid infiltration of spleen and liver. Mice undergoing treatment with carcinogenic compounds show a sudden, temporary and large increase of eosinophils in the blood, usually during the latter half of the latent period and before tumour development. Iron-reacting material is found to be progressively deposited in their lymph nodes.

It seems therefore that a combination of the responses of the tissues of normal mice to the administration of the individual pentose nucleotides reproduces with a singular exactness the systemic effects of tumour-growth, and it is difficult to exclude the possibility that pentose nucleotides may be liberated in the body during the development of primary or grafted sarcomas and induce the tissue changes mentioned above. This explanation might be related to the divergences between the nucleic acid content of tumours and that of the normal tissues of origin[3].

Experiments are in progress to investigate the relationships between the molecular structure of the nucleotides and these biological effects.

We are grateful to the British Empire Cancer Campaign for grants which have defrayed the cost of this investigation.

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Effect of Acute Starvation on the Adrenals of the White Rat

Since McCarrison[1] in 1919 and Vincent[2] in 1920 recorded the enlargement of the adrenals in the pigeon and the rat as a result of acute starvation, this anomalous result has been generally considered a hypertrophy[3-6]; no other tissue enlarges from such treatment.

We have shown that rats, given water but no food, develop a typical behaviour syndrome two or three days before death, in which at first they exhibit increased activity, and afterwards old animals show marked immobility. At this pre-mortal stage in old animals or the corresponding stage in younger rats, they have lost 30 per cent or more of their body-weight, and if they are killed the adrenals are found to be enlarged and discoloured to a dark grey or dark dirty grey. The enlarged glands contain an increased amount of water, though their solid content remains practically unaltered. In sections of the glands, cell nuclei counts in comparable areas measured from the periphery of the cortex inwards show a decrease when compared with normals. The change thus appears to be largely due to an increase in the water content of the cells. The glomerular zone is decreased in thickness and the reticular zone shows some signs of degeneration.

Hence adrenal enlargement in the pre-mortal stage of inanition appears to be a pathological process, perhaps in the nature of a hydropic degeneration, and is not a hypertrophy.

Animals killed before they have lost 30 per cent of their body weight still have adrenals normal in size, water content and colour.

Data in the literature suggest that certain types of adrenal enlargement such as that produced in the pigeon adrenal by deficiency of vitamins of the B-complex may be similar in nature, with discoloration[5], increased water content[3] and diminished cell nuclei in equal areas of sections[5].

The details of our experiments are in course of publication.

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Water Exchange between Insects and Air Moisture

It is well known that the weight of some fasting insects increases when they are exposed to an atmosphere saturated with water vapour. This phenomenon is generally considered to be due to the absorption of moisture from the air, and the insects concerned, such as *Leptinotarsa*[1], *Chortophaga*[2,3], *Cimex*[4] and *Tenebrio* (larvæ)[5] are often called 'hygroscopic'. The weight change is obviously influenced by a series of factors. In order to isolate the factor of 'hygroscopicity', we have kept the insects in air saturated with water vapour, the vapour being derived from water containing 8 per cent of heavy water; the vapour also contains 8 per cent of heavy water. The concentration of heavy water in the insects was determined after various exposures to this vapour by the method of Linderström-Lang[6].

Several species of insect were used. Some lose weight while fasting in saturated air; for example, *Tenebrio molitor* (Col.), adult; *Graphosoma lineatum* (Hem. Pentatomidæ), adult. Others gain weight under similar conditions; for example, *Tenebrio molitor* (Col.), larva; *Leptinotarda decemlineata* (Col.), adult.

We found that, to our surprise, the body water of all these insects, whether or not they are 'hygroscopic', comes into equilibrium with the atmospheric moisture, so that the insects also have 8 per cent of their water in the form of heavy water, in the course of a few days. This equilibrium is reached in thirteen days in the case of *Tenebrio* larvæ, nine days for the adults of the same species and for those of *Leptinotarsa*; five days for the adults of *Graphosoma*.

The only possible conclusion from these observations is that, under the conditions studied above, there is a continuous exchange between the atmospheric water vapour and the body-water of 'hygroscopic' and 'non-hygroscopic' insects. The body-water is, within a few days, completely replaced by water molecules from the atmosphere.

We are indebted to Prof. M. Florkin for suggesting the use of heavy water vapour.

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Rat Vectors of Plague

In view of the abundant evidence that *Rattus norvegicus* is a vecto of plague[1] it is perhaps of interest to record an outbreak not associated with this rat.

In Rangoon, immediately after the British reoccupation in May 1945, seventeen cases of human plague occurred between May 15 and August 29. Of these, eleven occurred in the district of Bahan to the north and west of the Royal Lake, two from the centre of the town, one from the district of Kemmendine, and the remaining three from villages outside the town. It is possible that in fact all cases were contracted in Bahan.

Rats from all parts of Rangoon were examined, and it was found that *Rattus norvegicus* occurred in the docks and town, but did not appear north of Kantawgale, a district to the south of the Royal Lake. It was absent from both Bahan and Kemmendine. Of 671 rats trapped and poisoned in Bahan, the percentage of different species is shown in the accompanying table. In this table is also shown the mean number of fleas per rat of 229 from Bahan and elsewhere, examined in August.

Species	No. in Bahan (per cent)	Mean fleas/rat of 229 examined in August from Rangoon	
		Xenopsyl'a astia	*Xenopsylla cheopis*
Bandicota bengalensis (Gray and Hardwicke)	29	1·5	0·2
Rattus norvegicus (Berk)	0	0·5	0·3
Rattus rattus (Linn)	13	0·1	0·1
Rattus concolor (Blythe)	45	0·2	0·3
Mus musculus (Linn)	8	0	1 flea only
Suncus caeruleus (Kerr) (Insectivora)	4	0·3	0·3

Only three rats were found infected with plague out of a total of 1,261 examined from the whole of Rangoon. All these were from Bahan, two being *Rattus rattus* and one *Bandicota bengalensis*.

In three cases where human plague deaths occurred, investigation produced a report of "white-bellied rats" dropping dead from the roof, a description which could only apply to *Rattus rattus*. The species in question is a local white-bellied form, probably near to *R. r. khyensis*.

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[1] Barnett, *Nature*, **157**, 105 (1946).

Apparatus for Measuring Mean Cell-Diameters in Blood Film

THE instrument I described earlier[1] is calibrated in relation to the use of the second red ring of the haloes. At the end it is noted that anisocytic spread of the spectra could so blur this band as to vitiate the method.

The answer to this difficulty was kindly sent to me by Dr. Adrianus Pijper, pioneer of the halometer method, who devised the Zeiss–Pijper blood cell tester. Those familiar with that instrument will be aware that not only is it fitted to compare two blood-smears, a great advance in reliability over the single-smear method, but also it is calibrated to make use of the yellow ring. Since this ring is central to the spectra, it is naturally the narrowest, and is not spread by anisocytosis. The discrepancies involved can be judged from the fact that a factor related to the rotundity of red cells was omitted from the equation used as a basis of calibration, and yet results were good.

I am indebted to Mr. G. Rogers, of Cambridge, for pointing out that since blood cells are not square, but round, the equation should read

$$\sin\theta = 1{\cdot}22Nl/M \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where θ is the angle of separation of the haloes, N the order of ring used, and l the wave-length of the ring.

It was noted that the wave-length which made the calibration coincide with that of the instruments previously used was somewhat short for the outer border of the red band, but there is a considerable surplus discrepancy which can only be accounted for by the spread of the red band.

The use of inferior practices is undesirable, and I am most grateful to Dr. Pijper for his criticism. I regret that I have not the figures to hand for the preparation of a table according to these principles. Whereas the table in my original communication suits the technique in use with the Eve halometer, familiar to so many, it is recommended that a fresh table be prepared according to the revised equation above, using a wave-length in the yellow. Of course, the Zeiss–Pijper blood cell tester is still more satisfactory.

HARRY HOGBEN.

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Nov. 25.

[1] *Nature*, **155**, 576 (1945).

Histological Technique for Endocrine Glands of Birds

WE have been making histological preparations of all the recognized endocrine organs (including thymus) of the common wild duck (*Anas platyrhyncha* p.L.) for some time. In the course of this work we gained some experience in the use of a number of methods of histological procedure as applied to these tissues, and it seems to us that our findings may be of value to others.

When fixing serial paraffin sections on the glass slide, we found that the sections of the adrenal glands showed a very strong tendency to become detached during passage through the reagents used for dehydration. We were unable to overcome this difficulty satisfactorily until we used a 1 per cent solution of commercial powdered albumen (Gurrs) as adhesive medium. This adhesive solution had to be made up fresh weekly even although a crystal of thymol was added to the bottle. Phenol may possibly be a more effective preservative. This solution was spread on the slide in the manner of making a blood film and the slide dried in an incubator. We found this solution far superior to the usual egg-white glycerin mixture[1] and also Hewer's potassium bichromate gelatine solution[2]. We found the 1 per cent solution sufficiently concentrated to ensure firm adhesion of the sections, without retaining the stain, a phenomenon which occurred readily with stronger solutions.

We tried out a number of differential stains for the anterior lobe of the pituitary (of the common wild duck), namely, Mann's methyl-blue eosin, long method[3], Biggart's eosin yellow and pyrrol blue[4], and Dawson and Friedgood's azocarmine and Mallory's azan[5]. The first two did not give a sharp differentiation of cell types in our hands. Dawson and Friedgood's method was satisfactory, but much more time-consuming than the modification of Crooke and Russell's acid fuchsin and Mallory's aniline blue mixture[6] to be described. The details of this method were given us by Dr. Keith C. Richardson, of the Department of Anatomy, University College, London, now published for the first time with his consent:

1. Fix the freshly dissected pituitary (or for birds, base of skull with pituitary *in situ*) in Zenker-formol (9 vol. Zenker, 1 vol. commercial formalin, neutralized to give an olive-green reaction with bromthymol blue) 8–12 (to 24) hours. 2. Wash out in running water overnight (for undissected pituitaries, decalcify). 3. Dehydrate and imbed in paraffin wax. Toluol, carbon disulphide or cedarwood oil are suitable clearing agents. 4. Cut sections at 4 μ or thinner, if possible. 5. Bring sections down to water, using iodine-alcohol to remove mercuric crystals. 6. Wash well with distilled water and stain one minute or longer in Altmann's aniline acid fuchsin (a saturated solution of acid fuchsin in aniline oil-water) (see techniques for staining mitochondria). The sections must be stained very strongly red. Heating the slide with a small amount of stain (filtered) over a spirit lamp until vapour comes off is recommended. 7. Wash quickly in distilled water to remove surplus stain. Differentiate in a saturated solution of picric acid. The stain should come out fairly rapidly, and the slide should be rinsed in water and examined from time to time under the microscope. Continue until the alpha cells are very strongly red and the rest are very light pink or even neutral in colour. 8. Wash well in distilled water to remove picric acid. 9. Place in 1 per cent phosphomolybdic acid for one minute. 10. Rinse in distilled water. 11. Transfer to Mallory's aniline blue-orange *G* (original formula: aniline blue, 0·5 gm.; orange *G*, 2·0 gm.; oxalic acid, 2·0 gm.; distilled water, 100 c.c.). The sections are left in this until the basophils are a strong blue and the chromophobes light grey or very pale blue. The length of time will vary with the material and with the degree of differentiation of the red (35 minutes for duck's pituitary). The slide may be rinsed with distilled water and examined during counter staining. 12. Rinse in distilled water, dry slide up to the edges of section; plunge in absolute alcohol until excess stain is removed; xylol, mount in Canada balsam.

Dr. Richardson has used this technique on a number of mammalian species with good results, and we can confirm that it is equally effective for the avian as well as the frog's pituitary, acidophils being stained sharply orange-red and basophils being fairly satisfactorily differentiated from chromophobes. It seems probable that the revised method for the 'Quad' stain' recently published, which we have not yet had an opportunity of trying, may give even sharper differentiation, as the blue stain (alizarin blue) is used separately from the orange *G* mixture as opposed to the combined solution used by us.

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L. A. WESTWOOD.

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London, S.E.1.
Jan. 17.

[1] Carleton, H. N., and Leach, E. A. G., "Histological Technique" (2nd ed., 1938), 74.
[2] Hewer, E. E., "Text-Book of Histology for Medical Students" (1937), appendix, 347.
[3] Carleton, H. N., and Leach, E. A. G., *op. cit.*, 431.
[4] Gatenby, J. B., and Painter, T. S., "Microtomists' Vade-Mecum" (10th ed.), par. 909.
[5] Dawson and Friedgood, *Stain Tech.*, **13**, 17–21.
[6] Gatenby, J. B., and Painter, T. S., *op. cit.*, par. 909.
[7] Kornhauser, S. I., *Stain Tech.*, **20**, 33–35.

Maintenance of Heterozygosity in a Homothallic Species of the *Neurospora tetrasperma* Type

IN the homothallic ascomycete *Neurospora tetrasperma*, two nuclei are normally included in each ascospore, one of mating type *A* and one of mating type *a*. *N. tetrasperma* is therefore normally a dikaryon and heterozygous for the *Aa* factors. It is interesting to note that the inclusion of an *A* and an *a* nucleus in one ascospore leads to the maintenance of heterozygosity of other factors *not on the same chromosome but segregating at the same time* as the *Aa* factors. A factor segregates at the first meiotic division if there has been no crossing-over between the factor and the centromere of the chromosome on which it is placed. If there has been such crossing-over the factor segregates at the second division. A factor placed about fifty cross-over units from the centromere would be expected to show 100 per cent second division segregation, apart from the effect of double cross-overs.

If we suppose that the *Aa* factors segregate at the first division, a pair of factors *Bb*, also segregating at the first division, will behave as illustrated in Fig. 1.

The resulting ascospores are heterozygous for *Bb* as well as for *Aa*. Each ascus contains only one type of spore, either *AB*, *ab* or *Ab*, *aB*, and there should be equal numbers of asci with *AB*, *ab* and *Ab*, *aB* spores.

If we suppose that the *Aa* factors segregate at the second division, the behaviour of the factors *Bb*, also segregating at the second division, is shown in Fig. 2. The diagram only takes into account the situation when *Aa* factors passing into one nucleus after the first division are re-associated in the spores, since other associations are unlikely to lead to the formation of four normal bisexual spores.

In this case half the asci should contain spores of two types, namely, *AB*, *ab* and *Ab*, *aB*. The occurrence or non-occurrence of the two types of spores within an ascus affords a method of determining whether the two factors segregate mainly at the first or second division.

Recently, Dodge, Schmitt and Appel[1] have published an analysis of the results of a cross involving *Dd*, for normal versus ascospore lethal, *Vv*, for normal versus dwarf habit and, of course, the *Aa* factors. It was found that the *Dd* factors rarely segregate in the progeny,

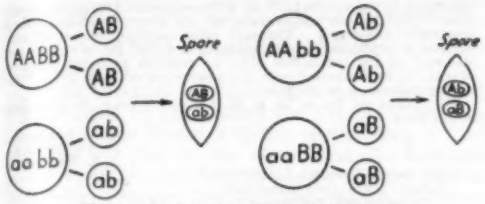

Fig. 1. *Aa* and *Bb* segregate at division I.

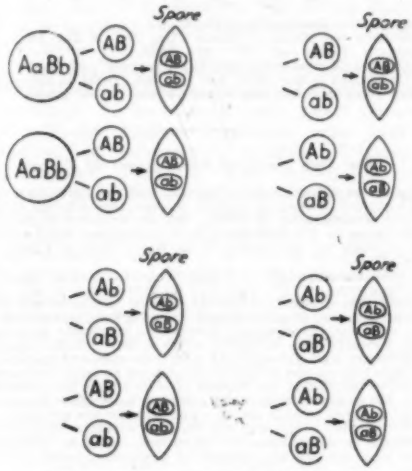

Fig. 2. *Aa* and *Bb* segregate at division II.

only two *dd* ascospores being found out of very many examined. The nuclear components of the 4 ascospores of 45 asci, 360 in all, were determined by obtaining somatic segregates of the ascospore cultures. Twenty-five asci contained spores of the *Ad*, *aD* type and twenty contained the *AD*, *ad* type. No ascus contained more than one type of spore. This indicates that the *Aa* and *Dd* factors usually segregate independently of each other at the first division. The *Vv* factors behave differently. Dodge *et al.* list 78 asci in which segregation of this factor does not occur and 39 asci in which *vv* and *VV* ascospores are found. This indicates that the *Vv* factors frequently segregate at the second division and that they must be situated at some distance from the centromere.

Suppression of segregation, like that shown by the *Dd* factors, is expected to occur whenever the recombinations of factors of the *Aa* type are restricted to the products of one meiotic division.

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Jan. 31.

[1] Dodge, B. O., Schmitt, B. Mary, and Appel, Anita, *Proc. Amer. Phil. Soc.*, **89**, 4, 575 (1945).

Genetics of Woodlice

I HAVE previously recorded in *Nature*[1] the results of a series of experiments I have made during the past two and a half years with two varieties of *Armadillidium vulgare* (Latr.), namely, Howard's type *D* and *rufobrunneus* Cllge.

In my last experiment I took one of the females of the brood of 52 females of *rufobrunneus* and crossed it with its male parent (type *D*), and as a result I obtained a brood of 37, all referable to the var. *rufobrunneus*. The brood consisted of 22 females and 15 males. There was no trace of the type *D*. Thus the var. *rufobrunneus* reproduced itself in both sexes.

I next took one of the males of this brood of *rufobrunneus* and paired it with two females of the same variety kindly sent to me by Dr. Hamilton E. Quick from Langland Bay, Swansea, Glam. As a result, I obtained two broods: one consisting of 37 females and 13 males, and the other of 43 females and 17 males, all referable to the var. *rufobrunneus*. The preponderance of females is noticeable. It is thus evident that the variety has again reproduced itself in both sexes and has eliminated the *D*-type strain entirely.

I have since tried to cross members of these two broods in order to ascertain if they would breed true, or if the Howard Type *D* would appear again, but so far I have not met with any success.

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[1] *Nature*, **154**, 797 (1944); **155**, 670 (1945).

New Records of *Eucrangonyx gracilis* S. I. Smith and *Gammarus tigrinus* Sexton

DURING a survey of the River Avon from Rugby to Stratford-on-Avon and of its tributary the River Sowe, new records of the amphipods *Eucrangonyx gracilis* and *Gammarus tigrinus* were made. The survey, which took place in August 1944, was made on behalf of the Water Pollution Research Laboratory of the Department of Scientific and Industrial Research, and the results are published by permission of the Department. General faunistic collections were made at stations several miles apart on the Avon, from Bretford Bridge to Stratford, and on the Sowe from Foleshill to its confluence with the Avon. Amphipods were absent from the Sowe except at Sowe Bridge, where a flourishing population of *Gammarus tigrinus* was present. In the very small tributary, the Smite, which joins the Sowe at this point, two *G. pulex* only were taken.

On the Avon, eight of the seventeen stations visited had no amphipods, probably because of an unsuitable substratum. At the other stations amphipods were nowhere abundant, and Bretford was the only station with a fair number present. These were mainly *Gammarus pulex*, but four *G. tigrinus* were also taken. In the thirteen miles from Stare Bridge to Barford Bridge collections at ten stations yielded only twenty-one amphipods; these were *Gammarus pulex* and *Eucrangonyx gracilis* in approximately equal numbers. *Eucrangonyx* was also present at Alveston Ferry and Tiddington, a few miles above Stratford.

According to Crawford[1], *Eucrangonyx gracilis* is a recent importation from North America. In a private communication, Mr. G. M. Spooner informs me he is publishing some notes on the species, having taken it in 1938 in well-separated localities in the Midlands. These included the River Avon at Tewkesbury, the Stratford-on-Avon Canal and Earlswood Reservoir in Warwickshire. It has been recorded by Reid[2] from Middlesex and is probably widely distributed in the Midlands.

Gammarus tigrinus was described by Sexton[3] from specimens taken in the Droitwich district. Mr. G. M. Spooner (unpublished) has seen a sample from Northern Ireland, but otherwise the records are restricted to the Severn-Avon watershed; the present records fit that distribution.

In view of the suggestion in Sexton's paper that *G. tigrinus* was inhabiting waters of peculiar composition, a request was made to the Water Pollution Research Laboratory, which has supplied the following analyses.

TABLE 1. COMPOSITION IN MILLI-EQUIVALENTS PER LITRE OF SAMPLES OF WATER COLLECTED ON SEPTEMBER 8, 1945, FROM RIVER AVON, NEAR COVENTRY. ANALYSES BY WATER POLLUTION RESEARCH LABORATORY.

Sampling point	Bretford Bridge	Stare Bridge	Blackdown Mill	Sowe Bridge	The Smite
Constituents:					
Na^+ (calc.)	3·60	5·57	7·68	26·06	0·52
Ca^{++}	6·80	6·10	5·45	8·15	5·95
Mg^{++}	3·10	2·70	2·20	4·30	2·20
Total cations	13·50	14·37	15·33	38·51	8·67
Cl^-	2·33	5·43	5·85	28·71	1·01
SO_4^{--}	6·07	5·04	5·38	4·60	2·06
HCO_3^-	4·10	3·90	4·10	5·20	5·60
CO_3^{--}	nil	nil	nil	nil	nil
Total anions	13·50	14·37	15·33	38·51	8·67
pH value at 16·5° C.	7·5	7·3	7·3	7·6	7·8
Total solids at 180° C. (gm./l.)	0·857	1·040	1·051	2·259	0·497

There is evidence of high sodium chloride content at Sowe Bridge as, for example, in Wyken Slough (Cooper, in Sexton[3]), but the presence of *G. tigrinus* at Bretford Bridge indicates that this high content is not always necessary.

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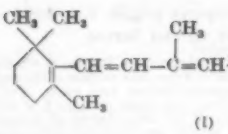
[1] *Nature*, **139**, 327 (1937).
[2] Synopses of Brit. Fauna No. 3. Gammaridæ (Linn. Soc. Lond., 1944).
[3] *J. Mar. Biol. Assoc.*, **21**, 543 (1939).

Substances Related to Vitamin A

THE successful and indeed most notable synthesis of 'vitamin A acid', that is, the C_{20} acid corresponding to the C_{20} alcohol, was described recently by J. F. Arens and D. A. van Dorp[1]. The publication of certain results which we have obtained while working on similar lines appears to be desirable.

We have been interested for some time in the application of Reformatsky reactions employing ω-bromo-ethylenic esters in syntheses in the vitamin A series. In our hands the condensation of methyl ω-bromocrotonate with β-ionone (regenerated from the semicarbazone) yielded an ester mixture, which, on hydrolysis, gave the crystalline C_{17}-acid (I) in 15 per cent overall yield from β-ionone, as a yellow crystalline solid, m.p. 160° uncorrected. (We presume that the m.p. (115·5–157·5° corrected) quoted by the Dutch authors is a misprint.) Our light-absorption data (max. 3250 A., log ε = 4·51) are in agreement with those quoted by the Dutch authors, and in



(I)

addition we have obtained further proof of the structure of this acid by the isolation of geronic acid (as its semicarbazone) in 34 per cent yield on ozonolysis, and by a quantitative hydrogenation (3·9 ethylenic bonds.)

Arens and van Dorp obtained the expected hydroxy-ester as the main product of their Reformatsky reaction and partially converted it into the ester of (I) by dehydration with anhydrous oxalic acid. In our experience the deliberate dehydration procedure is unnecessary, hydrolysis of the crude product either before or after distillation at 10^{-3} mm. giving material from which the fully conjugated acid (I) is readily isolated.

Although methyl sorbate can be brominated readily with N-bromo-succinimide to the *ω-bromo-ester*, numerous attempts to condense this vinylogue of the ω-bromocrotonate, with β-ionone, have failed completely to give any of the desired ester of the C_{19} acid. It had been intended to extend the synthesis, by using the ω-bromo-methyl-sorbate, to obtain the C_{20} acid corresponding to vitamin A.

We have converted the acid (I) into its *chloride* and at the present time the reaction of this substance with cadmium dimethyl is being studied. At the same time work is in progress on the condensation of the acyclic C_{14} and C_{15} aldehydes[2,3] with ω-bromocrotonate, and the related C_{17} and C_{18} ketones[3] with bromoacetate, in attempts to obtain acyclic acids related to vitamin A_2 on the assumption that vitamin A_2 is the lycopene analogue of vitamin A [4].

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E. R. H. Jones.
D. G. O'Sullivan.

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Feb. 18.

[1] *Nature*, **157**, 190 (1946).
[2] Batty, J. W., Burawoy, A., Heilbron, I. M., Jones, W. E., and Lowe, A., *J. Chem. Soc.*, 755 (1937).
[3] Barraclough, E., Batty, J. W., Heilbron, I. M., and Jones, W. E., *J. Chem. Soc.*, 1549 (1939).
[4] cf. Karrer, P., and Bretscher, E., *Helv. Chim. Acta*, **26**, 1758 (1943).

Absorption of Basic Dyes by Jute

It is well known that jute fibre has a strong natural affinity for basic dyes. This was formerly ascribed to the presence of tannins in the fibre[1]. Analysis of a fairly large number of jute samples of different qualities in this Laboratory has shown that though the plant contains some tannin, the retted fibre is practically free from it. According to Chowdhury and Mitra[2], acid constituents of the fibre, such as uronic acids, are responsible for this affinity. Some attribute it to the presence of lignin in the fibre. According to Parsons[3], for example, "delignified jute no longer has this property". The same statement also occurs in the latest edition of Whittaker's book[4]. Correct information in this regard is very important from the industrial point of view, for basic dyes are extensively used in dyeing jute, and if lignin be really the cause of absorption, fully bleached jute would not take up the dye unless mordanted.

In the course of our work on the isolation of cellulose from jute fibre[5], it has been observed that jute, completely delignified by means of sodium chlorite, absorbs, under identical conditions, practically the same amount of methylene blue as the original fibre. Further work has revealed that jute, delignified by different methods, behaves more or less similarly so far as the absorption of basic dyes is concerned. Some of the results of dye absorption measurements are shown below. Exhaustion of the dye-bath was determined colorimetrically, using a Klett colorimeter of the Duboscq type. The figures given in the table do not, however, represent the equilibrium absorption values which are, in all cases, considerably higher (in the case of raw jute and chlorite cellulose, the values are 21·33 and 32·9 respectively). The details of these experiments will be published elsewhere.

Sample	Dye absorption (millimoles/100 gm.)
Raw jute, defatted	5·51
Cross and Bevan cellulose ..	5·13
Norman and Jenkins's „ ..	5·73
Chlorine dioxide „ ..	5·49
Sodium chlorite „ ..	5·44
Filter Paper (Whatman No. 42) ..	1·45

(Fibre-liquor ratio = 1 : 50; pure methylene blue (Grübler) in millimolar solution (unbuffered); temperature, 22–25° C.; time, 2 hr.)

Even alpha-cellulose, prepared from any of these celluloses, absorbs a considerable amount of basic dyes (4·41 millimoles methylene blue per 100 gm.). Malachite green and acriflavine give similar results.

It would appear, therefore, that the presence of lignin is not responsible for the high absorption of basic dyes by jute. As regards the composition of the cellulose obtained by different methods, it has been shown[5] that, unlike other reagents, sodium chlorite removes no important constituent besides lignin.

The ash alkalinity (milliequivalents of acid required to neutralize ash obtained from 100 gm. of the bone-dry material) of jute fibre is high—11·07 for the fibre used in these experiments—but this does not appear to be related directly to the absorption of basic dyes. When this figure is reduced to 0·73 by treatment with decinormal hydrochloric acid at room temperature, the dye absorption value remains practically unchanged. The acid value (milliequivalents of alkali required to neutralise the acid liberated from 100 gm. of the bone-dry material) of the cation-free fibre, or cellulose prepared therefrom, appears to be connected with the absorption of basic dyes. Work in this direction is in progress.

Our thanks are due to Mr. C. R. Nodder, director, for his interest in this work.

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H. Chatterjee.
A. K. Mazumdar.

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Calcutta.
Dec. 18.

[1] Barker, "Jute Research in 1935–36", 23.
[2] Chowdhury and Mitra, *J. Indian Chem. Soc.*, **9**, 291 (1932).
[3] Parsons, *J. Textile Inst.*, **30**, *P* 322 (1939).
[4] Whittaker, "Dyeing with Coal Tar Dyestuffs", 82 (4th ed., 1942).
[5] Chatterjee and Sarkar, *Proc. Nat. Inst. Sci., India*, in the press.
[6] Sarkar and Chatterjee, *Science and Culture*, **10**, 340 (1945).

The Two Heats of Atomization of Carbon

In a recent communication, Sidgwick and Springall[1] have referred to the current division of opinion between two different values for the heat of atomization of carbon, and the apparent support for the higher value (~ 170 kcal./gm.-atom) forthcoming from the figures they calculate for the energies of the Hg—C links in $HgMe_2$, $HgEt_2$ and $HgPh_2$.

In calculating these energy values, the heat of atomization of carbon into the ground, or ^5P, state was employed, that is, the quantity Herzberg[2] has termed L_1. This procedure is justifiable only for compounds containing divalent carbon, it having been pointed out twelve years ago[3] that the imaginary dissociation of organic molecules into atoms normally leads to carbon atoms in the ^5S state (that is, the lowest energy-level corresponding to tetravalence), and that the energy difference between the ^5S and ^5P states must be taken into consideration when calculating the energies of carbon links for compounds in which the carbon is tetravalent. Neglect to consider the excitation energy of the ^5S state is mainly responsible for the apparent conflict in experimental values and the state of confusion that at present dominates the thermochemistry of carbon, failure to distinguish between bond energies and energies of dissociation being a subsidiary cause.

This subject is fully reviewed by us in a forthcoming paper in which it is shown that virtually all experimental quantities can be brought into alignment. Consideration of the energies required to remove a hydrogen atom from molecules of methane and ethane, and of the energies of reorganisation of the resulting radicals, indicates that the heat of sublimation of carbon into free atoms in the ^5S state is of the order 190 kcal./gm.-atom. With certain tacit assumptions, Cherton[4] has independently deduced the same figure from a spectroscopic study of acetylene. This quantity, which we have termed L_5, leads in turn to a satisfactory assignment of values to the strengths of carbon bonds, including the more reasonable value ~ 22 kcal. for the Hg—C link in $HgMe_2$, it being assumed that the mean C—H bond energies in ethane and $HgMe_2$ are not widely different. The excitation energy of ^5S carbon has not been experimentally determined, but there is strong chemical evidence for believing the estimate of 100 kcal. by Bacher and Goudsmit[5] to be roughly 50 per cent in excess of the true value.

In the light of the foregoing, there remains no sound evidence in support $D(CO) = 11{\cdot}11$ eV. and $L_1 = 170$ kcal., the arguments of Kynch and Penney[6] in favour of these values being based on false premises, including the tacit assumption that the ^3P and ^5S states of carbon are at one and the same energy-level: and the recent speculations of Gaydon and Penney[7] are vitiated by the employment of this erroneous figure for $D(CO)$. By far the most probable value for L_1 remains Herzberg's figure, 125 kcal. (corresponding to $D(CO) = 9{\cdot}14$ eV.), which at least must be regarded as being of the right order.

Direct measurement of the equilibrium conditions obtaining at the triple point of carbon[8] provides excellent confirmation of this figure, as can be demonstrated by reference to the hypothetical curves of Goldfinger and Jeunehomme[9], whereas the observed vapour pressure is several hundred times larger than that necessitated by $L_1 = 170$ kcal. Moreover, to Herzberg's additional arguments[10] must be added other supporting considerations dealt with in our paper.

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R. G. W. Norrish.

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Cambridge.
March 5.

[1] Sidgwick, N. V., and Springall, H. D., *Nature*, **156**, 599 (1945).
[2] Herzberg, G., "Molecular Spectra and Molecular Structure—1: Diatomic Molecules", 521 (New York: Prentice-Hall, 1939).
[3] Norrish, R. G. W., *Trans. Farad. Soc.*, **30**, 103 (1934).
[4] Cherton, R., *Bull. Soc. roy. Sci. Liège*, **11**, 203 (1942); *Bull. Soc. Chim. Belg.*, **52**, 26 (1943).
[5] Bacher, R. F., and Goudsmit, S., *Phys. Rev.*, ii, **46**, 948 (1934).
[6] Kynch, G. J., and Penney, W. G., *Proc. Roy. Soc.*, A, **179**, 214 (1941).
[7] Gaydon, A. G., and Penney, W. G., *Proc. Roy. Soc.*, A, **183**, 374 (1945).
[8] Basset, J., *J. Phys. Radium*, vii, **10**, 217 (1939); *Brennstoff-Chem.*, **23**, 127 (1942).
[9] Goldfinger, P., and Jeunehomme, W., *Trans. Farad. Soc.*, **32**, 1591 (1936).
[10] Herzberg, G., *J. Chem. Phys.*, **10**, 306 (1942).

SCIENCE IN CZECHOSLOVAKIA AND YUGOSLAVIA

A DISCUSSION on "Science in Czechoslovakia", arranged by the Society for Visiting Scientists, was held at the Society's House on February 1. Dr. Jan Masaryk was in the chair, and the speakers were: Prof. J. Bělehrádek, rector of the Charles University, Prague; Dr. J. Cisar, chargé d'affaires, Czechoslovak Embassy; Prof. E. G. Cox, University of Leeds; Dr. S. C. Dykes; Sir Alfred Egerton; Prof. A. Stampar, rector of the University of Zagreb; and Dr. Nora Wooster.

Dr. Cisar began the discussion by a brief historical outline of the scientific background of Czechoslovakia, during which he mentioned such great names as Kepler, Tycho Brahe, Comenius, who laid the foundations of educational science, Bolzano the mathematician, Purkyně, who coined the word 'protoplasm', Mendel, the founder of modern genetics, Doppler and Ernst Mach. Based on such traditions, modern Czech science has maintained a good international average, which it is hoped would soon be regained and even surpassed. He left it to Prof. Bělehrádek, who spent the war years under Nazi police supervision, and finally in a concentration camp, to describe the terrible years of Nazi occupation: the closing down of all university buildings as well as the technical colleges and schools, which were the real centres of scientific research; the imprisonment of thousands of Czech intellectuals and students; and the execution of a number of scientific men and student leaders. All scientific activity was strictly forbidden, and any attempt to teach science was considered as sabotage; laboratories were taken over by professors from the German University in Prague; clinics and hospitals were put under German direction. Prof. Bělehrádek's own Department of General Biology at the medical faculty was transformed into an Anstalt für Rassenhygiene. Couples intending to marry were examined, measured, weighed and photographed here, and their 'racial' characters determined.

The disorganisation of Czechoslovak science is deep. It is the result of six years of complete cessation of research activities, complete isolation from the outer world, with no possibility of obtaining journals and books from abroad; grave material damage to many laboratories, and the dismantling and removal to Germany of much valuable apparatus. The situation is further complicated by a serious depletion of academic personnel, and by the greatest influx of students ever experienced. There are to-day 52,000 students at the universities and technical and related schools in Czechoslovakia, out of a population one third the size of that of Great Britain. In Prague alone, there are 3,000 first-year medical students, and 2,000 more in Brno, Bratislava and Královĕ. Lecturing, practical work and examination absorb the whole time and energy of the teaching staff; dance halls have to be hired for lecturing to the huge classes of students, and practical demonstration is reduced to a minimum. Under such conditions, very little research can be done.

The Czech Government has set up a central planning office in Prague, which is considering these problems; the organisation of scientific research is an important part of its programme. The Office has begun its work, fully aware of the difficulties and the years of hard work ahead, but with a great deal of courage and optimism.

Dr. Stampar, rector of the University of Zagreb (now vice-chairman of the Security Council of the United Nations Organisation), painted a picture of Yugoslovak science not very different from that of Czechoslovakia: wanton destruction of libraries, of laboratories, complete isolation and cessation of work under the mixed domination of Germans and quislings, and a mortality of 10 per cent of the population (and higher still for students) in the struggle for freedom. Yet the liberation has brought the same influx of new students, all eager to learn and work. Cinemas and public halls have been taken over for lecturing, 30,000 students now attending. Their spirit is remarkable; they are organising clubs, dining-rooms and dormitories; they help in the repair work of the buildings; they cut wood to heat the lecture halls and laboratories; they have traced much stolen equipment. But here, too, there is a terrible shortage of staff, books and equipment, and it will need all their courage and determination, as well as considerable help from the Allies, to re-organise scientific life.

The other speakers, Sir Alfred Egerton, Dr. Nora Wooster, Prof. E. G. Cox and Dr. Dykes, who had recently visited Czechoslovakia, all stressed the terrible sense of isolation from which scientific workers there are suffering, and their eagerness and urgent need to re-establish contacts. The lack of scientific literature cannot be sufficiently emphasized, and it is hoped that anyone who can will send books, reprints or scientific journals to help fill the gap. Exchange of scientific men will also be of enormous value in helping to re-establish the key position of fundamental research. Owing to economic necessity, the tendency has been towards technological problems, and this, as well as the fact that the younger students have inevitably been infected with Nazi ideology, has tended to discourage a truly scientific outlook.

With reference to Prof. Heyrovský's important work on the polarograph, a suggestion was made that its manufacturers should subsidize research on the subject in Czechoslovakia. (Only one firm had paid any royalties so far to Prof. Heyrovský, and that was a Swedish firm.)

The chairman, Dr. J. Masaryk, wound up the discussion with a brief allusion to the political difficulties which had faced his country after the liberation. He concluded with these words: "Help us to free our souls and the soul of our national genius".

CHROMATOGRAPHIC ANALYSIS

A MEETING of the Physical Methods Group of the Society of Public Analysts and Other Analytical Chemists was held on February 26 to discuss "Chromatographic Analysis". Four papers were read, two dealing with principles, and two with applications of the method to analytical problems.

Mr. F. A. Robinson described Tswett's classical experiment, in which the pigments of green leaves were separated from one another by pouring a petroleum ether extract of the leaves on to a column of calcium carbonate, and 'developing' with fresh solvent. The method has since been applied not only to the separation of many other coloured substances but also to the separation of numerous colourless substances; but, whereas the position of coloured constituents on a column is self-evident, various

devices have to be employed to indicate the position of each colourless component. These include inspection of the column in ultra-violet light, painting the extruded column with a suitable reagent, chromatography of coloured derivatives and addition to the mixture of a dyestuff with the same adsorption affinity as one of the components.

The relation between structure and adsorption affinity, the principles to be used in selecting adsorbents and eluants, and the methods in use for the standardization of adsorbents were briefly described. Reference was also made to fluid chromatography, in which solvents of progressively increasing eluant power are run through the column in succession, thus eluting the constituents one after another, in the order of increasing adsorption affinities. Tiselius' use of *schlieren* boundaries for indicating the removal of components from charcoal 'chromatograms was described and also Tiselius' 'displacement chromatography', in which solutions of substances such as ephedrine, with high adsorption affinities, are added to the eluant to displace strongly held components of a mixture.

The chromatographic principle has also been applied to the separation of substances by methods not dependent on adsorption. Thus basic or acidic substances can often be separated by ion exchange on columns of zeolite, or amberlite resins or on columns of alumina containing adsorbed sodium or hydrogen ions. Partition chromatography is the name given to a method of separating substances by virtue of their relative partition coefficients on columns of silica gel or other substances capable of absorbing water. Inorganic ions have been separated on columns of specific organic reagents such as 8-hydroxy quinoline. Finally, a brief account was given of the theories put forward to explain chromatographic separation.

"Partition Chromatography" was dealt with in greater detail by Dr. R. L. M. Synge who, in collaboration with Dr. A. J. P. Martin, devised the technique in 1941. The bands produced in adsorption chromatography generally have diffuse rear edges or, more rarely, diffuse 'fronts', owing to the non-linear nature of the adsorption isotherms. The distribution of solutes between two liquid phases, however, gives rise to linear distribution isotherms, and it was considered possible that chromatograms on powdered silica gel saturated with the aqueous phase of a chloroform-water mixture would give sharp bands when developed with chloroform. This expectation was realized, and the method has since been used extensively, although it is limited to the separation of substances of relatively low molecular size and the results are frequently complicated by adsorption on the silica gel, which tends to make the bands diffuse. Among the most important applications of this method are the separation of amino-acids and their derivatives, peptides, fatty acids and methylated sugars. Instead of silica gel, starch and filter paper have also been used for the identification of amino-acids and peptides; filter paper has the advantage that only minute amounts of material are required.

An important modification of the original method is the use of buffered solutions in place of an aqueous solution for saturating the silica gel; this was of particular value in the purification of the penicillins. It is known that the partition coefficient depends on the contribution of all the groups in the molecule irrespective of their geometrical arrangements, whereas these are of great importance in adsorption. It may therefore be concluded that partition chromatography is best for the separation of fatty acids, for example, and adsorption chromatography for the separation of *o*-, *m*-, and *p*-isomers. Association and ionization may result in distortion of the distribution isotherms and, in such instances, the bands will tend to be diffuse. The effect of ionization can be controlled by using buffered solutions, so that the ratio of un-ionized to ionized acid is maintained constant. This not only leads to sharper bands, but also enables substances to be separated which in the un-ionized form travel down the column too quickly or which have similar partition coefficients in the un-ionized state but differ in *p*K.

Mr. K. A. Williams discussed "Chromatography in the Analysis of Fatty Oils". Selective adsorption of the constituents of a mixture depends on the relative affinities of adsorbent and solvent for the solutes, and chromatographic adsorption may be regarded as the result of a competition between them, other solutes, however, influencing the relative degrees of attraction. The first applications of chromatography to the analysis of oils was made with the unsaponifiable constituents, when it was shown that the adsorption of the carotenes on magnesium oxide was correlated with their degree of unsaturation and conjugation; the presence of hydroxyl groups increased the adsorption affinity. The hydrocarbon constituents of the unsaponifiable matter of oils are not adsorbed on a column of alumina, whereas unsaturated alcohols tend to collect towards the bottom of the column, sterols one-third of the way down, xanthophylls somewhat higher up and saturated alcohols at the top. When linseed oil is chromatographed on alumina, fractions containing 7, 6, 5 and 4 double bonds per molecule are obtained, the more unsaturated glycerides being adsorbed at the top and the less unsaturated at the bottom of the column. The constituents of a mixture of fatty acids, however, are adsorbed in the reverse order, the more saturated acids at the top and the less saturated at the bottom. This reversal is understandable if adsorption affinity is regarded as due to the algebraic sum of the positive polarity due to hydroxyl or carboxyl groups and the negative polarity of the double bonds. Of the simple chromatographic methods now available for use in commercial analysis, the following were described: the removal of free fatty acids from fat by alumina; the estimation of hydrocarbons in vegetable and animal oils; the estimation of carotene, xanthophylls and vitamin A in unsaponifiable matter; and the estimation of oxidized fatty acids.

"Some Applications of Chromatographic Analysis in Industry" was the title of the paper presented by Dr. F. R. Cropper. He described the method used for preparing and standardizing activated alumina, now available in Great Britain at a reasonable price, and discussed a number of its applications. It has proved of great value in separating anthraquinone derivatives from one another and in studying the constitution of competitive dyestuffs. It has also been used for the detection and estimation of fluorescent compounds, such as anthracene, in intractable materials like tar and pitch. An acid-washed alumina was used for studying the breakdown products of thiobarbituric acids; and magnesium carbonate columns proved satisfactory for investigating compounds that formed lakes with alumina.

Filter paper has found extensive application in testing the quality of dyestuffs intermediates. A solution of the substance to be tested is diazotized

and coupled, or simply coupled, with a suitable diazo reagent, and dropped on to the centre of a filter paper placed between glass plates. On development, concentric rings are formed, and the intensity of the colour due to the impurity is compared with that given by a standard. It is possible that filter paper partition chromatography may have similar applications, but these have not yet been adequately explored. Dr. Cropper illustrated many of these applications by means of demonstrations and exhibits.

A lively discussion ensued, in which many additional points were made. One speaker said that although unsaturated glycerides could be separated into groups, as described by Mr. Williams, it has not been found possible to isolate each individual species chromatographically, as had been hoped. Reference was also made to Urey's separation of the isotopes of lithium on a column of adsorbent 30 ft. long. Several speakers referred to the need for further investigation into the chromatographic separation of inorganic substances, which in many ways is less satisfactory than the separation of organic substances; the zones often overlap and extremely dilute solutions have to be used. Ion-exchange columns also suffer from the disadvantage that the zones run into one another, and the components cannot be separated merely by cutting the column. It was suggested that displacement chromatography may overcome this difficulty and give purer fractions. A modification of the filter-paper method described by Dr. Cropper was mentioned in which a thin layer of adsorbent is placed between two glass plates and used in the same way. Another speaker advocated the use of silica gel for adsorption, but stressed the importance of using a very finely divided powder; others said they had found silica gel to be unsatisfactory. Questions were also asked about the possibility of isolating the colouring matter of jams and of cigarette tobacco by means of chromatography. The question, "What *is* light petrol?" caused some amusement, until it was explained that 'light petrol' was not what it used to be, and nowadays frequently contains aromatic hydrocarbons which may well upset the equilibrium of the chromatogram—and possibly that of the chromatographer as well.

WAR-TIME CIVILIAN CONSUMPTION OF GOODS

COMPARISONS of respective sacrifices in a common cause can never tell the full tale; but in such situations as that exemplified by the recent statements on food policy, it is expedient that the facts should be agreed and put on record. The report to the Combined Production and Resources Board from a special Combined Committee on Non-Food Consumption Levels, entitled "The Impact of the War on Civilian Consumption in the United Kingdom, the United States and Canada"*, deserves to be read by a far wider circle than those economists and statisticians or other specialists to whom the data tabulated in the appendixes, which occupy the greater part of the report, may be primarily of interest. The summary alone is well designed to facilitate that fuller understanding by each country of the circumstances and accomplishments of the others, which it is rightly assumed is essential to a combined approach to their common problems. In ten chapters covering in turn changing consumption levels and patterns, food, alcoholic beverages and tobacco, clothing, housing, fuel and electricity, household goods, other personal effects, amusements and reading matter, transportation and communication, and miscellaneous services, the report provides plenty of objective measurements on a basis affording fair comparisons.

Some of the comparisons are striking. In the United Kingdom, aggregate *per capita* purchases of consumer goods and services, valued at pre-war prices, decrease 15–20 per cent from 1939 to 1941–43, whereas in Canada and the United States they were 10–15 per cent higher than in 1939, in which year the physical volume *per capita* of consumer purchases was probably 10–20 per cent lower in the United Kingdom than in the United States. Moreover, in important categories of consumption, consumer purchases decreased in the United Kingdom and increased in the United States and Canada. Both limited imports and the overall shortage of labour were important factors in the United Kingdom declines. At pre-war prices, consumption of food per head increased in the United States and Canada, and decreased in the United Kingdom, but nutrient standards were in general maintained with substantial readjustments of diet. Again, not only did purchases of civilian clothing and household soft goods, etc., increase in the United States and in Canada and decrease in the United Kingdom, but also these decreased purchases include those required to cover damage and destruction by enemy attack; this quite apart from the effect of the long-continued low level of such purchases leading to consumers' wardrobes and linen closets including by 1943 and 1944 a large proportion of items that even by war-time standards in the United States and Canada would be classed as worn out.

Some types of consumer purchases declined and a few groups increased in all three countries, and in some categories such as amusements, railway travel and communication services, it was not possible to separate civilian purchases from purchases by members of the Armed Forces; and in so far as there is reason to believe that the average serviceman's expenditure on these items was considerably above that of the average civilian, the increases in purchases per head overstate the true change in civilian consumption, particularly in the United Kingdom, where the number of troops was proportionately larger.

Generally, the impact of the War on consumption in the United States and in Canada came later; and its effects on consumption were more gradual and less severe than in the United Kingdom, where the war effort absorbed a major fraction of national resources nearly a year earlier than in Canada and a year and a half earlier than in the United States. In 1943 and 1944, war production represented about half the total gross product in the United Kingdom and Canada and about 40–45 per cent in the United States. The war products of the three countries were to some extent complementary: the United Kingdom had a considerably higher—about 30 per cent in 1944—proportion of its man-power in the Armed Forces and was enabled to do so partly because of the contributions of food, raw materials and munitions from Canada and the United States. In all three countries, additions to the stock of non-war buildings and capital equipment ceased, many capital goods

* London: H.M.S.O., 1945. 2*s*. 6*d*. net.

were not replaced as they wore out, and business inventories of civilian goods showed that the latter were down. When peace-time uses of war surplus property are taken into account, only in the United Kingdom was there a net reduction in national wealth, and that reduction was material.

There are three main reasons for the decrease in the level of consumption in the United Kingdom while purchases increased in Canada and the United States. First, the total national production could not be expanded as much as in the other two countries. The total supply of labour imposed an overall limit on United Kingdom production, although restrictions on the use of labour for non-war output were developed to an extent not attempted in the United States and Canada even in 1944. Secondly, the United Kingdom was very dependent on imports of food and basic materials, and such imports were limited by the shortage of shipping. Thirdly, because the impact on civilian production came earlier and was longer continued in the United Kingdom, business inventories of consumer goods were earlier depleted there; in Canada and the United States they were still helping to keep consumer purchase above production in 1944.

TRAINING AND SUPPLY OF APPLIED BACTERIOLOGISTS

THE rapid advances in knowledge which have taken place in bacteriology in recent years, the increasing importance of biological studies in academic curricula and of their impact on industrial research, and the emphasis now laid on the place of science in the social and industrial structure, have made it highly desirable that the training of bacteriologists should be adequate for the tasks ahead and that the growing demand for bacteriologists in different fields should be met by a corresponding supply of trained personnel from the various centres. These questions were considered with some care at recent meetings of a sub-committee appointed by the Society of Applied Bacteriology and including representatives of the Society for General Microbiology. This committee included members with experience in teaching, in research, and in advisory work, and was constituted as follows: Dr. L. A. Allen, Prof. B. T. P. Barker, Prof. H. D. Kay, Dr. T. Gibson, Mr. D. A. McKenzie, Dr. T. Richards, Dr. R. T. St. John-Brooks, Prof. J. F. D. Shrewsbury, and Mr. S. B. Thomas.

A review of the courses of training available in Great Britain, in faculties of pure science or of agriculture, showed that, prior to 1940, bacteriology was included as one subject in a pass degree at four universities, that in two of these universities, and in two others, there was an honours school in which bacteriology was the main subject; and that a course for a post-graduate diploma in bacteriology, which was open to graduates in pure science, was offered by three universities, two of which did not provide a degree course in this subject. One other university intends shortly to start a course for an honours degree.

With these facilities it might well be thought that an adequate supply of bacteriologists would be forthcoming each year, due allowance being made for the shortage of trained men of science brought about by the effect of the War on university courses. It is, however, the experience, both of university teachers and of those directing research in institutes and in industrial laboratories, that the number of students qualifying in bacteriology has not been equal to the number of posts to be filled in this field. Well-trained recruits are also urgently needed for work in agricultural and veterinary bacteriology. What are the reasons for this lag between supply and demand? Can an effective remedy be provided?

The committee was unanimous in the feeling that the most urgent need lay in the recognition of bacteriology as an independent biological science. This need arises from the history of the development of bacteriology, which has been less fortunate than that of most of the other sciences. In these latter sciences a long period of fundamental studies has preceded their use in solving problems in an applied field. The study of bacteriology, on the other hand, was, until comparatively recently, largely incidental to the solution of some practical problem, and the fundamental study of the subject was neglected. Some of the difficulties to which this inevitably gave rise have been gradually met by a new approach to the subject during the last twenty years, decades marked by notable advances in knowledge. Tradition dies hard, however. There is still in some quarters a tendency to push bacteriology under the protective wing of one of the older disciplines, with resulting detriment to the knowledge of the student and to his status with his subsequent employer. It is clear that in the future bacteriology must be treated first as an independent biological science, and that its applications to medicine, agriculture and industry must be treated afterwards. An essential step would appear to be the establishment in universities of chairs of bacteriology which are independent of 'applied' faculties.

Research institutes and research departments in industry, both in Britain and in some of the overseas Dominions and Colonies, require each year a number of bacteriologists who have received a few years' training in research and are suitable for posts of intermediate seniority. The committee was of the opinion that this requirement would be most surely and satisfactorily met by the establishment of several research scholarships for selected post-graduate students, of the annual value of not less than £300 and tenable for two or three years at universities or at research institutes. The holders of these scholarships would form a balancing reserve between supply and demand, and those industrial firms and other establishments in which bacteriology plays an important part might well consider the mutual advantage, to research centres and to themselves, of making a substantial contribution to the foundation of such scholarships.

Another reason, which has been operative in the past, for disinclination on the part of students to embark on bacteriology as a career, has been the uncertain prospects of advancement in industry. This situation arose rather naturally during a period when the subject was regarded as a minor adjunct to some other science. It is perhaps necessary to impress upon those responsible for the direction of research in industry that adequate training in bacteriology can only be grafted on a sound basic knowledge of natural science, particularly of chemistry and the biological sciences, and that a man who has received this training is entitled to the same status and prospects as is the chemist and the physicist. For the same reasons a distinction should be drawn between those whose knowledge fits them only for carrying out the more routine work in bacteriology,

and those whose thorough training in the subject fits them to become, after the necessary experience, self-reliant research workers.

Briefly, then, the committee's recommendations for dealing with this urgent problem are: (1) that bacteriology should be recognized, in universities and elsewhere, as an independent science; (2) that research scholarships in bacteriology should be established in universities and research institutes; and (3) that industry should recognize the value of the trained bacteriologist and should offer him status and prospects which are attractive. In the minds of those conversant with the subject, no doubt exists as to the magnitude of the contribution which bacteriologists can make to the history of progress. The committee feels strongly that this contribution will be more effective and much more quickly realized if the suggestions it has made are considered, at an early date, jointly by the two groups mainly concerned, namely, those who train bacteriologists, and those who employ them.

THERMOTHYRIN A AND B: TEMPERATURE-REGULATING HORMONES OF THE THYROID

By Dr. ANN MANSFELD
Institute for Experimental Pathology and Pharmacology, University of Pecs

THE role of the thyroid gland in temperature regulation through chemical means has been investigated by G. Mansfeld in a series of studies which have at last been summarized in his monograph on "The Hormones of the Thyroid Gland and their Actions" (Basle, 1943, Benno Schwabe and Co.). The principal results of these studies are as follow.

(1) By means of serum transfer experiments it was shown that the temperature regulation not only against cold, but also against heat, is accompanied by the secretion of substances which decrease the level of the oxidative processes in normal animals, and that the secretion of these substances is dependent on the intact function of the thyroid gland.

(2) An analysis of the action of thyroxine has shown that the thyroxine sensitivity of the organism during the months March–November is decreased to such an extent that it is necessary to administer three times the amount of thyroxine in order to get the same increase of oxidation as during the winter months. After removal of the thyroid gland, the animals become as sensitive to thyroxine during the summer as they were during the winter.

(3) G. Mansfeld succeeded in preparing an active extract by hydrolysis of thyroid glands which not only decreased the higher sensitivity to thyroxine of winter animals, but also lowered the level of oxidation in normal animals and in animals in which the metabolism had been raised by thyroxine.

(4) It could be shown that this activity of the extracts was due to the action of two substances, which have been termed thermothyrin A and B.

These substances have been obtained in the crystalline state. They were isolated not only from the thyroid gland, but also from the sera of human beings and animals. It was found that thermothyrin A is produced throughout the whole year when human beings or animals are exposed to high temperatures ('cooling hormone'); thermothyrin B is produced during the summer months, independently of the external temperature ('summer hormone of the thyroid gland'). Thermothyrin A has a melting point of 53° C. Elementary analysis of three samples which were in good agreement among themselves gave the following mean values: C, 80·73; H, 13·93 per cent. From these figures the empirical formula is calculated as $C_{20}H_{42}O$ (calc.: C, 80·46; H, 14·18); or $C_{20}H_4O$ (calc.: C, 81·0; H, 13·6). The molecular weights, determined cryoscopically in exaltone, was found to be 290 (calc. for $C_{20}H_{42}O$, 296).

Thermothyrin B has a melting point of 66° C. Elementary analysis of six samples which were in good agreement among themselves gave the following mean values: C, 85·15; H, 14·87 per cent. Thus, thermothyrin B consists only of carbon and hydrogen. From the analytical figures the empirical formula is calculated as $C_{20}H_{42}$ (calc.: C, 85·01; H, 14·98). The molecular weight, determined cryoscopically in exaltone, was found to be 277 (calc. for $C_{20}H_{42}$, 282).

Injections of 1 mgm. doses of these substances into rats produce a lowering of oxidation, which after five days still amounts to about 50 per cent, and disappears only after nine days.

The elucidation of the chemical constitution of these highly active hormones is in progress.

FOSSIL FLORAS OF THE KAREWA SERIES

THE Karewa series are deposits laid down in an ancient lake in Kashmir and now exposed on hillsides and in the valley at elevations of 5,500–10,600 ft. The flora is rich, including many dicotyledons (mostly identified as hill trees and shrubs), monocotyledons (mostly lowland aquatics), gymnosperms and abundant algæ. The aquatics are of special interest because they are not known to occupy elevations greater than 5,200 ft. at the present time in the Himalayas. This suggests that the lake deposits may have been afterwards raised at least 5,000 ft.—a conclusion in accordance with recent geological views. The flora from different localities is distinctly diverse. That from Liddarmarg (altitude 10,600 ft.) is tropical in its trees, including such genera as *Ficus*, *Quercus*, *Litsæa*, etc. Such genera occur at present at a low altitude of 3,000–6,000 ft. in the Himalayas.

The flora of Laredura (altitude 6,000 ft.) includes a mixture of temperate genera such as *Æsculus*, *Juglans* with tropical genera, which are, however, so strongly developed as to suggest at least a sub-tropical climate. The Ningal Nullah flora discovered at an altitude of 9,000 ft. consists exclusively of temperate genera such as willows, poplars, walnuts and elms such as grow at present in Kashmir at 7,000–10,000 ft.

The age of all these fossiliferous deposits is regarded as Lower Pleistocene, and De Terra and Patterson think they may belong to the first Interglacial period. According to a communication to the Editors submitted by Dr. G. S. Puri, of the University of Lucknow, at present working at University College, London, it now proves unlikely that they all belong to one period, for the first two floras are tropical or sub-tropical and suggest an elevation lower than 6,000 ft., while the third flora, which suggests an elevation a good deal higher, must have grown at a rather different period and perhaps a different Interglacial after the level had been raised.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, April 15

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON STUDENTS' SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. R. C. Kyme: "A Modern Telephone Exchange".

Tuesday, April 16

ROYAL ANTHROPOLOGICAL INSTITUTE (in the Eugenics Theatre, University College, Gower Street, London, W.C.1), at 5.15 p.m.—Special Meeting. Prof. l'Abbé Henri Breuil: "La découverte de l'antiquité de l'homme et quelques unes de ses evidences" (Huxley Memorial Lecture).

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1), at 6.30 p.m.—Mr. C. C. Hodgson: "Metallurgy and the Development of the High Speed Diesel Engine".

Wednesday, April 17

BRITISH INSTITUTION OF RADIO ENGINEERS (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6.15 p.m.—Dr. Hilary Moss: "The Electron Gun of the Cathode Ray Tube, Part 2".

ROYAL INSTITUTE OF CHEMISTRY (at the Royal Institution, Albemarle Street, London, W.1), at 6.30 p.m.—Dr. J. H. Oliver: "Recent Advances in Brewing Technology".

SOCIETY OF DYERS AND COLOURISTS (at the Bell Hotel, Leicester), at 6.30 p.m.—Mr. D. Entwistle: "Synthetic Fibres from Natural Polymers".*

Wednesday, April 17—Thursday, April 18

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), in connexion with the meeting at Oxford on April 12–15 of the Permanent Council of the International Congress of Anthropological and Ethnological Sciences.

Wednesday, April 17

At 1.30 p.m.—Rev. Prof. W. Schmidt: "Some Anthropological Notes from Switzerland and Austria"; at 2.15 p.m.—Prof. G. Lindblom: "Anthropology and Ethnology in Sweden during the last Seven Years"; at 5 p.m.—Prof. H. V. Vallois: "L'Anthropologie en France durant la guerre"; at 5.45 p.m.—Prof. G. H. Rivière: "L'Organisation des Musées d'ethnographie française".

Thursday, April 18

At 1.30 p.m.—Prof. E. Tamagnini: "Progress in Portugal in Anthropological and Ethnological Studies".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT MASTER (Graduate) to take MATHEMATICS and PHYSICS, an ASSISTANT MASTER (Graduate) to take ADVANCED ELECTRICAL TECHNOLOGY with ADVANCED PHYSICS as a subsidiary subject, and an ASSISTANT MASTER (Graduate) to take PURE AND APPLIED MATHEMATICS for Advanced Engineering Courses—The Principal, Enfield Technical College, Queensway, Enfield, Middx. (April 20).

DEMONSTRATOR IN THE DEPARTMENT OF CHEMISTRY, an ASSISTANT IN THE DEPARTMENT OF GEOGRAPHY, and a DEMONSTRATOR IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (April 23).

GRADUATE LECTURER IN ENGINEERING—The Clerk to the Governors, Mid-Essex Technical College and School of Art, Chelmsford (April 24).

LECTURER IN PHYSICS—The Principal, Technical College, Kingston-on-Thames, Surrey (April 29).

PRINCIPAL OF AN AGRICULTURAL TRAINING CENTRE at Risehoime, near Lincoln—The Secretary, Lindsey War Agricultural Executive Committee, County Council Offices, Newland, Lincoln (April 30).

ASSISTANT LECTURERS (2) IN THE DEPARTMENT OF GEOGRAPHY AND ANTHROPOLOGY—The Registrar, University College, Aberystwyth (April 30).

LECTURESHIPS IN CHEMISTRY (two parts), and a LECTURESHIP IN BIOCHEMISTRY—The Secretary, Middlesex Hospital Medical School, London, W.1 (April 30).

PSYCHOLOGIST—The Medical Superintendent, City Mental Hospital, Winson Green, Birmingham 18 (May 1).

LECTURER IN EDUCATIONAL STATISTICS—The Secretary, University of London Institute of Education, London, W.C.1 (May 1).

LECTURER IN BOTANY—The Registrar, University College of North Wales, Bangor (May 5).

CITY ANALYST—The Town Clerk, Municipal Buildings, Dale Street, Liverpool 2, endorsed 'City Analyst' (May 6).

READERSHIP IN CHEMISTRY tenable at Bedford College—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 7).

ASSISTANT LECTURER (man or woman) IN MATHEMATICS—The Registrar, University College, Southampton (May 11).

PRINCIPAL—The Secretary, University College, Dundee (May 15).

LECTURER IN MATHEMATICS AND APPLIED MATHEMATICS, and a LECTURER IN ELECTRICAL ENGINEERING, in the Natal University College, Durban—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (May 15).

ASSISTANT LECTURER (Grade III) or LECTURER (Grade IIc) IN MATHEMATICAL PHYSICS, and a LECTURER (male) IN THE DEPARTMENT OF PURE MATHEMATICS—The Secretary, The University, Edmund Street, Birmingham 3 (May 31).

LECTURER IN THE CHEMISTRY OF GLASS in the Department of Glass Technology—The Registrar, The University, Sheffield (May 31).

LECTURESHIP IN MATHEMATICAL PHYSICS, a LECTURESHIP IN PSYCHOLOGY (including Experimental Psychology), and a LECTURESHIP IN BOTANY—The Secretary, Queen's University, Belfast (June 1).

PROFESSOR OF PHYSICS—The Registrar, The University, Dacca, India (June 30).

LECTURER OR ASSISTANT LECTURER IN MECHANICAL ENGINEERING—The Secretary, King's College, Strand, London, W.C.2 (June 30).

LECTURER IN DENTAL PATHOLOGY AND BACTERIOLOGY—The Registrar, The University, Liverpool (June 30).

SENIOR LECTURER IN PHYSIOLOGY—Prof. I. de Burgh Daly, The University, Edinburgh (June 30).

HEAD OF THE ENGINEERING DEPARTMENT, Barrow-in-Furness Technical College—The Chief Education Officer, Education Offices, John Whinnerah Institute, Barrow-in-Furness.

LECTURER IN ELECTRICAL ENGINEERING, a LECTURER IN MECHANICAL ENGINEERING, a LECTURER (Graduate) FOR MATHEMATICS AND SCIENCE, and a TEACHER OF ENGINEERING AND TECHNICAL DRAWING at the proposed new Technical College—The Chief Education Officer, Education Offices, Town Hall, Peterborough.

CHIEF AGRICULTURAL OFFICER—The Director, Sugar Experiment Station, Mount Edgecombe, Natal, South Africa (apply by Air mail).

GLASS-BLOWER for scientific work—The Registrar, The University, Leeds 2.

SENIOR LABORATORY ASSISTANT for the DEPARTMENT OF PHYSICS—The Registrar, The University, Liverpool.

ASSISTANT LABORATORY TECHNICIAN for the PHYSICS DEPARTMENT—The Warden and Secretary, London (Royal Free Hospital) School of Medicine for Women, 8 Hunter Street, London, W.C.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

University Education and Business. Report of a Committee appointed by the Cambridge University Appointments Board together with a Summary and Analysis of Evidence collected for the Committee. Pp. viii+78. (Cambridge: At the University Press, 1945.) 2s. 6d. net. [1810

Imperial Bureau of Pastures and Forage Crops. Bulletin 34: The Establishment and Early Management of Sown Pastures. Pp. xi+210+36 plates. (Aberystwyth: Imperial Bureau of Pastures and Forage Crops, 1945.) 7s. [1810

Geological Survey of Great Britain. Wartime Pamphlet No. 45: The Mineral Resources of the Lothians. By Dr. A. G. MacGregor. Pp. 44. (London: Geological Survey and Museum, 1945.) 2s. [1810

British Rubber Producers' Research Association. Publication No. 61: The Structure of Polyisoprenes, 1: The Crystal Structure of Geranylamine Hydrochloride. By G. A. Jeffery. Pp. 18. (London: British Rubber Producers' Research Association, 1945.) [1810

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Scottish Society for Research in Plant-Breeding. Report (abridged) by the Directors and Report by the Director of Research to the Annual General Meeting, July 19, 1945. Pp. 34. (Edinburgh: Scottish Society for Research in Plant-Breeding, 1945.) [1810

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Volume presented to Prof. Chaim Weizmann on the Occasion of his 70th Birthday by the Division of Plant Pathology of the Agricultural Research Station, Rehovot, Palestine, November 1944. Pp. 77-208. (Rehovot: Agricultural Research Station, 1944.) [238

Government of Cyprus: Water Supply and Irrigation Department. Water Supply in Cyprus, a General Report. By Dr. C. Raeburn. Second revised edition. Pp. 54. (Nicosia: Government Printing Office, 1945.) 3s. [238

Report of the Science Service, Dominion Department of Agriculture, for the Year ended March 31, 1944. Pp. 72. (Ottawa: Dominion Department of Agriculture, 1945.) [238

Ontario Research Foundation. Annual Report, 1944. Pp. 32. (Toronto: Ontario Research Foundation, 1945.) [238

United States Department of Agriculture. Circular No. 720: Controlling Insects in Flour Mills. By R. T. Cotton, J. C. Frankenfeld and G. A. Dean. Pp. 76. (Washington, D.C.: Government Printing Office, 1945.) 15 cents. [238

Proceedings of the United States National Museum. Vol. 95, No. 3184: The Fulgoroidea, or Lanternflies, of Trinidad and adjacent parts of South America. By R. G. Fennah. Pp. 411-520+plates 7-17. (Washington, D.C.: Government Printing Office, 1945.) [238

United States National Museum. Bulletin 185: Checklist of the Coleopterous Insects of Mexico, Central America, the West Indies, and South America, Part 3. Compiled by Richard E. Blackwelder. Pp. iii+343-550. (Washington, D.C.: Government Printing Office, 1945.) [238

Fondation Universitaire. Vingt quatrième Rapport annuel, 1943-1944. Pp. 80. (Bruxelles: Fondation Universitaire, 1945.) [288

Imperial College of Tropical Agriculture. Interim Report on Cacao Research, 1943-44. Pp. 8. (Trinidad: Imperial College of Tropical Agriculture, 1945.) 1s. [288

Uganda Protectorate: Forest Department. Annual Report for the Year ended 31st December, 1944. Pp. 8. (Entebbe: Government Printer, 1945.) 1s. [288

Indian Research Fund Association. Report of the Scientific Advisory Board for the Year 1st January to 31st December, 1944. Pp. vii+188. (New Delhi: Indian Research Fund Association, 1945.) 1 rupee. [288

Summary Report on Work done in the All-India Institute of Hygiene and Public Health for the Period 1940 to 1944. Pp. 40. (Calcutta: Government of India Press, 1945.) [69